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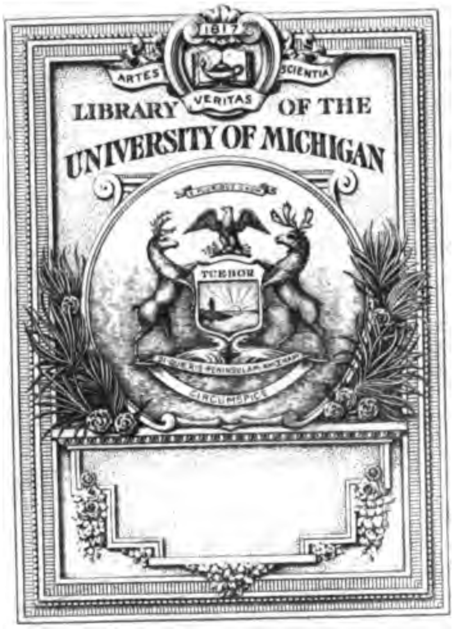
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BULLETIN

OF THE

UNITED STATES FISH COMMISSION.

VOL. XII,

FOR

1892.

MARSHALL McDONALD, Commissioner.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

Joint Resolution authorizing the Public Printer to print Reports of the United States Fish Commissioner upon new Discoveries in regard to Fish-culture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Public Printer be, and he hereby is, instructed to print and stereotype, from time to time, any matter furnished him by the United States Commissioner of Fish and Fisheries, relative to new observations, discoveries, and applications connected with fish culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding five hundred pages. The extra edition of said work shall consist of five thousand copies, of which two thousand five hundred shall be for the use of the House of Representatives, one thousand for the use of the Senate, and one thousand five hundred for the use of the Commissioner of Fish and Fisheries.

February 14, 1881.

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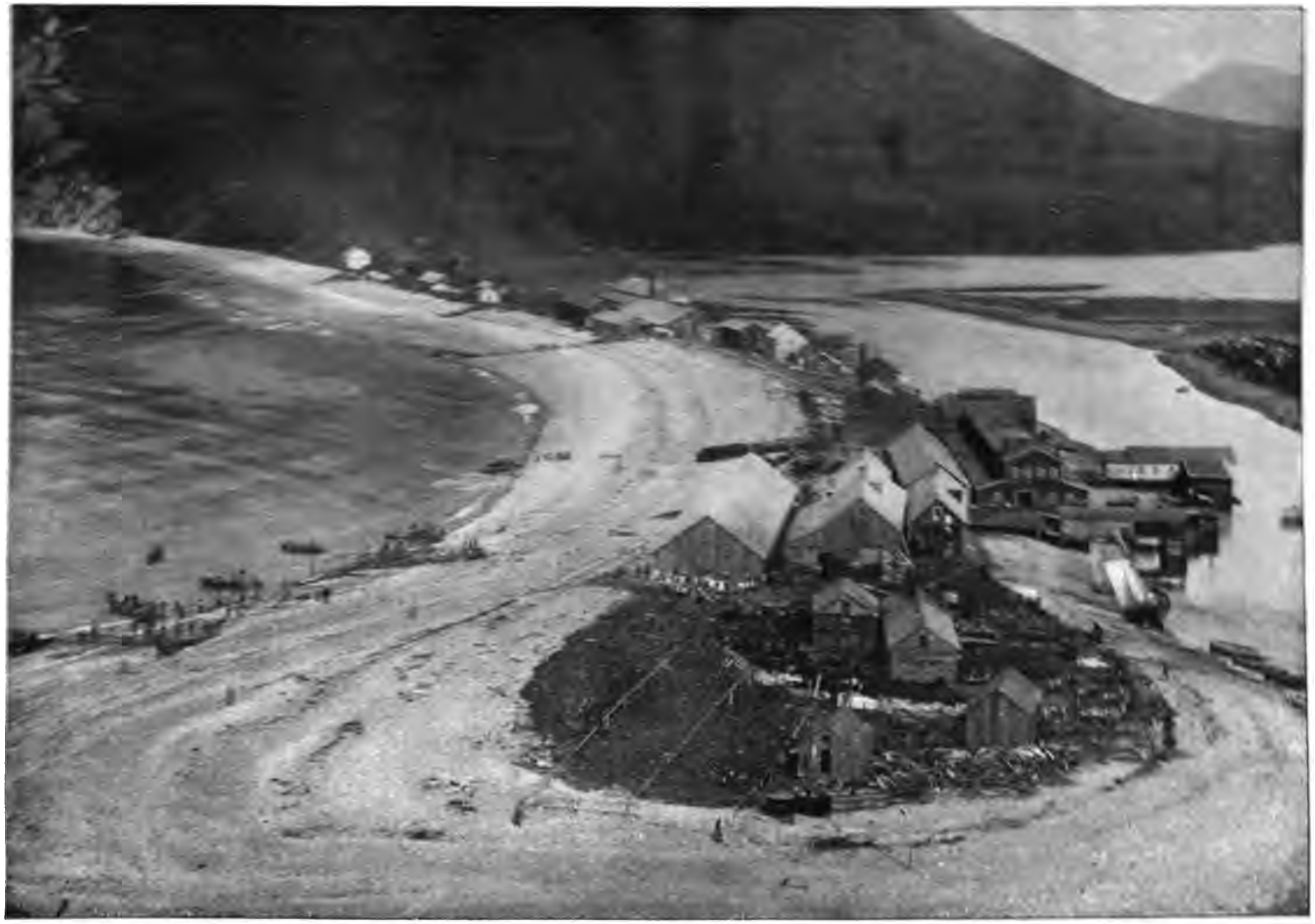

KARLUK PENINSULA, SHOWING CANNERIES, SEINING OPERATIONS, AND KARLUK RIVER.

1.—REPORT ON THE SALMON FISHERIES OF ALASKA.

By MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries.

U. S. Commission of Fish and Fisheries,
Washington, D. C., July 2, 1892.

Hon. Levi P. Morton,
President United States Senate:

Sir: In obedience to a resolution of the Senate of the United States, directing the Commissioner of Fish and Fisheries "to communicate to the Senate any information in his possession relative to salmon fishing in Alaska, its extent, and whether the methods employed in catching salmon are likely to diminish the supply and eventually exterminate the salmon; together with his opinion as to what measures should be adopted for the protection and preservation of the salmon industry in Alaskan waters," I have the honor to transmit herewith a brief report, discussing the subject under the following captions:

1. Origin and development of the Alaskan salmon fisheries.
2. Statistics of the fisheries.
3. Present condition of the fisheries.
4. The methods and apparatus employed.
5. The protective regulation of the fisheries, including recommendations as to further legislation in reference to them.

Appended to this communication, and making a part of it, is a paper upon the life history of the salmon, by Dr. T. H. Bean, ichthyologist of the Commission. For convenience of reference I have also appended a bibliography, as far as could be ascertained in the limited time at my disposal, of publications relating to the salmon of Alaska and adjacent waters.

ORIGIN AND DEVELOPMENT OF THE ALASKAN SALMON FISHERIES.

The marvelous abundance of several species of salmon in Alaskan waters has been long known, but in consequence of the remoteness of this region and its inaccessibility, the abundant supply in rivers nearer markets, and a disposition on the part of buyers to underrate Alaskan products, its fishery resources have not been laid under contribution for market supply until within a few years, during which we have seen,

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Note.—This paper was first published as Senate Miscellaneous Document No. 192, Fifty-second Congress, first session. The subject discussed is of such general interest that it was thought advisable to give the report a wider circulation and a more permanent form by inserting it as an article in the Bulletin.

as the result of reckless and improvident fishing, the practical destruction of the salmon fisheries of the Sacramento and the reduction of the take on the Columbia to less than one-half of what it was in the early history of the salmon-canning industry on that river. At present the streams of Alaska furnish the larger proportion of the canned salmon which find their way to the markets.

The pioneer in the early development of the salmon-canning industry in Alaskan waters was the Alaska Commercial Company, which in 1887 established a cannery on Karluk River on the west side of Kadiak Island, and packed about 13,000 cases of salmon. The enterprise proved exceedingly profitable, and operations were rapidly extended so that the pack of this company on the Karluk River in 1888 aggregated 101,000 cases of 48 pounds each, representing a catch of over 1,200,000 bluebacks or red salmon in the estuary of a small stream, with a volume and drainage area not exceeding that of Rock Creek (the small stream flowing through the Zoölogical Park and discharging into the Potomac River within the city limits of Washington, D. C.). The enormous production of this year was secured by entirely obstructing the river by running a fence across so that no fish could pass up, and by continuing canning operations without intermission until late in October, when most of the fish were dark and unfit for food.

The immense pack made by the Alaska Commercial Company in 1887 and 1888, the fame of which quickly extended to San Francisco, had two important results. The attention of Congress was directed to the inevitable disaster that would overtake the salmon fisheries of Alaska unless prompt measures were taken to restrain the improvident and destructive methods employed for the capture of the salmon. Accordingly, upon the recommendation of the Commissioner of Fisheries, an act for the protection of the salmon fisheries of Alaska was introduced into Congress and became a law on March 2, 1889, as follows:

AN ACT TO PROVIDE FOR THE PROTECTION OF THE SALMON FISHERIES OF ALASKA.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction.

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

SEC. 3. That section 1956 of the Revised Statutes of the United States is hereby declared to include and apply to all the dominion of the United States in the waters of Bering Sea; and it shall be the duty of the President, at a timely season in each year, to issue his proclamation and cause the same to be published for one month in at least one newspaper, if any such there be, published at each United States port of entry on the Pacific coast, warning all persons against entering said waters for the purpose of violating the provisions of said section; and he shall also cause one or more vessels of the United States to diligently cruise said waters and arrest all persons, and seize all vessels found to be, or to have been, engaged in any violation of the laws of the United States therein.

This act, though authorizing and directing the Secretary of the Treasury to establish such regulations and surveillance as should be necessary to insure that the prohibition would be enforced, neither prescribed the machinery nor appropriated the means to carry it into effect. Some restraint has doubtless been imposed upon attempts at violation of the law where they are likely to come under observation, but it is probably violated without hesitation or scruple where the chance of discovery is casual or remote.

STATISTICS OF THE FISHERIES.

The immense take of salmon in the estuary of the Karluk River in 1887 and 1888 had the additional result of attracting attention to a field promising such extravagant returns for the capital invested. More than 30 new canneries were established during the season of 1889. Five were located on the sand-spit at the mouth of the Karluk River, and 3 others so near as to draw their supplies from that source. Over 350,000 cases of red salmon, representing 4,000,000 of fish, were taken from this insignificant rivulet in 1889, and sent into the markets of the world. During this season there were 36 canneries in operation in Alaska, and the value of the salmon pack amounted to $3,375,000.

The following table, showing the Alaskan salmon pack from 1883, when systematic canning operations were first instituted, to 1890, after they had probably reached their largest development, is very interesting as well as suggestive; interesting, as illustrating the wonderful wealth of the waters; suggestive, because we know that it has been accomplished by irrational and destructive methods, and by improvident, willful, and contemptuous disregard of natural laws, whose aid and unobstructed operation are essential to the maintenance of a continuing and productive salmon fishery in Alaska.

The Alaska salmon pack from 1883 to 1890.

Year.	Number of cases.	Year.	Number of cases.
1883	36,000	1887	190,200
1884	45,000	1888	298,000
1885	74,850	1889	675,000
1886	120,700	1890	610,747

A review of the statistics of the salmon pack of Alaska from 1883 to 1890, compiled from data gathered by the Division of Fisheries of the U. S. Fish Commission, shows that the total yield of the salmon fisheries of this region from 1883 to 1890, both inclusive, was 2,050,497 cases of 48 pounds each, representing an aggregate production of 28,706,958 salmon within the period mentioned. During the first three years the pack was small, viz, 36,000 cases in 1883, 45,000 cases in 1884, and 74,850 cases in 1885. After this the increase in production was phenomenal, and in 1889 had reached the enormous amount of 675,000. Production in the subsequent years receded slightly, but the aggregate for 1890 and 1891 did not fall much short of the pack of 1889. Of the entire Alaskan yield, about one half is taken from the estuary of the Karluk River. Adding the product of 1891 to the aggregate for previous years, we have a total yield of canned salmon since 1883, when regular canning began, amounting to nearly 2,750,000 cases, and a total value of $11,000,000.

Besides the canned salmon, the rivers of Alaska yield annually nearly 7,000 barrels of 200 pounds each of salt salmon. When we add to the above production the enormous quantities of salmon which are consumed by the natives, in the fresh and dried condition, we shall be able to form some adequate idea of the immense value of the Alaskan salmon, and the importance of fostering and establishing conditions of permanence for this great resource.

In 1889 the salmon fishery gave employment to 66 vessels, including 13 steamers, 13 barks, 2 brigs, and 1 ship. Thirty-six canneries were in active operation, not counting a number of small establishments whose pack was light, and incidental to general trading with the natives. The capital stock of these canning companies ranged from $75,000 to $300,000. The estimated capital was $4,000,000, and the value of the pack $3,375,000.

PRESENT CONDITION OF THE FISHERIES.

OBSTRUCTIONS IN THE RIVERS.

Early in April, 1890, information reached the Commissioner of Fisheries in regard to a salmon trap, the construction of which had been determined upon by four cannery firms located on the Nushagak River. About 25 miles from the mouth of this river is a tributary known as Wood River, into which most of the salmon entering the Nushagak make their way for the purpose of spawning in the two large lakes at its head. Believing that such action was a violation of the act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, the Commissioner transmitted the information to the Secretary of the Treasury with the suggestion that the necessary steps be taken by some of the Treasury officials in that region. The matter was referred to the chief of the Revenue-Marine division with the recommendation that if possible the captain of one of the Revenue-Marine steamers cruising in Alaskan waters be directed to make an investigation, and, if necessary, have the obstructions removed and the guilty parties arrested and prosecuted.

On April 12 the chief of the Revenue-Marine division returned the correspondence to the Commissioner of Fisheries with the information that the commanding officers of the Revenue-Marine steamers cruising in Alaskan waters during the ensuing season would be instructed to enforce the law for the protection of the fisheries as far as circumstances would permit. He suggested also that the commanding officer of the Fish Commission steamer *Albatross* be instructed to investigate the complaint and enforce the law if found necessary. Inasmuch as the Commissioner of Fisheries did not have authority to give directions for the enforcement of the law, he wrote to the chief of the Revenue-Marine division on April 17 that if the Secretary desired to confer the necessary authority upon the commanding officer of the *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, he would take pleasure in forwarding the same. On the following day, therefore, the acting Secretary of the Treasury, Hon. George S. Batcheller, forwarded to the Commissioner of Fisheries the following order, clothing the commander of the *Albatross* with the necessary authority to act in the matter, inclosing at the same time copies of Treasury circular of March 16, 1889, in relation to the matter.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., April 18, 1890.

SIR: You are hereby clothed with full power and authority to enforce the provisions of law contained in act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, which prohibits the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds.

Respectfully, yours.

GEO. S. BATCHELLER,
Acting Secretary.

Lieut. Commander Z. L. TANNER,
Commanding U. S. Fish Commission Steamer Albatross,
San Francisco, Cal.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., March 16, 1889.

TO COLLECTORS AND OTHER OFFICERS OF THE CUSTOMS:

The following provision of the act approved March 2, 1889, entitled "An act to provide for the protection of the salmon fisheries of Alaska" is hereby published for the information and guidance of all concerned:

"That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction."

Collectors and other officers of the customs, and officers under the jurisdiction of this Department who may be assigned to duty in Alaska, will see that the requirements of said section are strictly observed, and that no dams, barricades, or other obstructions are placed in any of the rivers of Alaska with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds; and should any such dams, barricades, or other obstructions be discovered, to warn the persons who erected the same to immediately remove them and thereafter report the persons (with statement of facts) to the United States attorney of Alaska for prosecution under the said section, and also to forward duplicate reports to this Department for its information.

Officers of the Revenue-Marine Service on duty in Alaskan waters are hereby required, so far as practicable, to assist officers of the customs in Alaska in seeing that the requirements of the statute are strictly enforced.

HUGH S. THOMPSON,
Acting Secretary.

On April 23 a letter of instructions was forwarded to Lieut. Commander Tanner, calling his attention to the existence of a trap or dam on Wood River, as also to the order of the Secretary of the Treasury directing the Revenue-Marine steamers to enforce the law as far as circumstances would permit, and to the request that the steamer *Albatross* make an investigation and carry out the provisions of the law in case of its violation. Lieut. Commander Tanner was directed to make this one of the first objects of his cruise in Bering Sea, and to comply with the instructions of the Secretary of the Treasury as fully as possible. His report, after making the investigation, was as follows:

UNALASKA, ALASKA TERRITORY, *June 15, 1890.*

Hon. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

DEAR SIR: I have the honor to inform you that the *Albatross* anchored in the Nushagak River on June 3. I visited the four canneries located on that stream the following day. They use gill nets almost exclusively in taking salmon, although three of them have a small trap in the immediate vicinity of their establishments. They are all dry at low tide, and when fish are found in them men go in and pick them up from the ground.

The fourth cannery had a trap formerly, but did not find it profitable. Nothing that can be called an obstacle to the free passage of salmon exists in the Nushagak River.

I learned from Mr. J. W. Clark, one of the projectors, and others, that a union trap was in process of construction in Wood River, and in order to ascertain the character and present condition of the work I took Mr. P. H. Johnson, who has charge of the enterprise, and Mr. Clark, in one of the ship's boats, and steamed to the point indicated, which I found to be about 20 miles above its mouth.

Wood River at that point is a stream of pure cold water between 700 and 800 feet in width and 10 feet deep at low tide; rise, 3 to 4 feet.

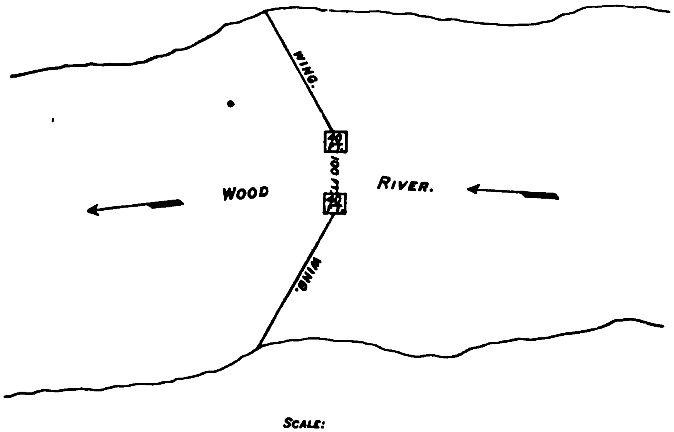
The work of trap-building was in progress, a group of ten piles having been driven about 300 feet from shore, and lying on the bank were a portion of the nets required to mount the finished structure. Operations were not sufficiently advanced to enable me to judge their intention, and I can only give the plan as detailed to me by the builders. Mr. Clark stated that the plans contemplated two 40-foot square traps, with wings extending to the shore on either side, an open channel of 100 feet being left in midstream for the passage of the salmon; that he had joined the enterprise with the stipulation that this passage should be left unobstructed at all times.

In reply to a question, he said that he had lived in the country many years as a fur-dealer, and the thickly populated region on Wood River contained many of his best customers; hence he would have no hand in anything that would injure them. An obstruction in the river preventing the run of salmon would result in actual starvation to the majority of the natives.

Mr. P. H. Johnson, the prime mover in the affair, described the plans precisely as Mr. Clark had done. He considered the traps as an experiment involving too much money to be expended by either of the canneries singly; hence, he had endeavored to interest all four, and finally succeeded, Mr. Clark having joined them with the provision that a free passage of at least 100 feet should be left in the middle of the river. He said this stipulation was agreed to willingly, as they never had an idea of barricading the stream. The inclosed sketch shows the plan as given to me by the gentlemen mentioned; and the blue prints [not reproduced] give an accurate idea of the present state of the structure. It will be observed that, while a 100-foot channel will serve for the ascent of salmon, complete barricade of the stream can be accomplished with a net of that length, 12 to 15 feet in depth. Whether this simple appliance will be used depends, in the absence of a Government inspector, upon the canners themselves.

Very respectfully,

Z. L. TANNER,
Lieutenant Commander, U. S. Navy, Commanding.



NOTE.—The river is at this point about 750 feet wide; depth at mean low water, 10 feet; rise, 3 to 4 feet.

UNALASKA, ALASKA TERRITORY, *June 18, 1890.*

Hon. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries:

DEAR SIR: In looking over my letter regarding the construction of traps in Wood River it occurs to me that I may not have explained my action very definitely. It is generally understood here that the act of March 2, 1889, does not prohibit the ordinary use of the trap, and that when a practicable channel is left for the passage of salmon they may lawfully be used. As I did not feel fully competent to argue the point I advised them to keep within the law, as the Government intended to enforce it strictly and would exact the full penalties for its infraction.

If it is the intention of the act to prohibit the use of traps, I would respectfully suggest that it be so stated in a Treasury circular. It would simplify matters very much if the Treasury Department would state definitely what the canners may or may not do under the act of March 2, 1889.

Very respectfully,

Z. L. TANNER,
Lieut. Commander, U. S. Navy, Commanding.

This correspondence was referred to the ichthyologist of the Commission, who made the following report:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., July 24, 1890.

Col. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries:

SIR: After having considered the letters of Lieut. Commander Z. L. Tanner, U. S. Navy, dated June 15 and 18, 1890, referring to the construction of a trap in Wood River, Alaska, I respectfully offer my opinion that such a contrivance for the capture of salmon is of the nature of an obstruction which would impede and, in all probability, prevent the ascent of salmon to their spawning-grounds. It is, therefore, clearly a violation of the act approved March 2, 1889, a portion of which is quoted herewith:

[PUBLIC No. 158.—An act to provide for the protection of the salmon fisheries of Alaska.]

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction."

It has been demonstrated that traps in salmon rivers will speedily exterminate the salmon. Newfoundland furnishes a satisfactory illustration of this fact. So well is this matter understood that British Columbia forbids altogether the capture of salmon in narrow reaches of streams, and the rivers are guarded to see that the close time and other regulations are observed; the length of nets and their size of mesh are fixed by law; even the offal from canneries is not allowed to lie in the way of ascending fish.

The Alaskan salmon firms are in the territory to get fish. They prefer to get them without injury to the future of the business if possible, but get them they must or be overcome by financial disaster In their efforts to win success they have often stretched nets across the mouths of small streams and prevented the salmon from going up until a sufficient number had collected to make a good seine haul possible. They have erected traps in rivers in such a way as to stop every salmon from ascending and, in some cases, actually built impassable barricades to prevent the ascent of fish entirely until the demands of the canneries were satisfied. Even when fishing regulations were adopted by mutual agreement among the firms interested, individual infractions of the rule were only too frequent.

The trap men on Wood River are building upon the well-known habit of the quinnat (or king salmon) of following along the shores in shallow water to escape from enemies. All the conditions, both natural and invented, will favor the entrance of salmon into the great inclosure at the end of the leader of netting. In all probability few salmon will swim in midchannel and reach the upper waters and lake sources of the river, and it will always be possible to cut off this remnant in the manner suggested by Lieut. Commander Tanner and actually practiced by fishermen on occasions, that of stretching a seine across the open water. If the Government should interpret its act so as to allow the use of traps, in spite of the unfortunate outcome of such appliances in neighboring countries, it should then prescribe regulations for the conduct of the fishery and appoint agents to see that the laws are enforced. If these matters are left solely to the discretion of the individuals having a financial interest in the fishery, there will soon be no salmon to protect.

Very respectfully,

T. H. BEAN,
Ichthyologist, U. S. Fish Commission.

The papers relating to the obstruction of Wood River were transmitted to the Secretary of the Treasury by the Commissioner of Fish and Fisheries, with the following letter:

WASHINGTON, D. C., *July 31, 1890.*

The SECRETARY OF THE TREASURY, *Washington, D. C.:*

SIR: Referring to your communication of April 18 last, forwarding to Lieut. Commander Z. L. Tanner, U. S. Navy, commanding the Fish Commission steamer *Albatross* on the Pacific coast, a letter clothing him with full power to enforce the provisions of the Alaskan salmon law, with special reference to obstructions which it was reported were to be constructed in the Nushagak and Wood rivers, I have the honor to transmit herewith for your consideration several documents bearing upon that subject, namely:

Copies of two letters from Lieut. Commander Z. L. Tanner, with their inclosures, dated Unalaska, Alaska, June 15 and 18, and a copy of a letter from Dr. T. H. Bean, ichthyologist of the U. S. Fish Commission, dated July 24.

Lieut. Commander Tanner reports having visited the Nushagak and Wood rivers on June 3. He found no obstructions in the former river, but in the Wood River two traps were in process of construction, with wings leading to the shore and leaving a passageway in the middle of the river 100 feet wide. Not feeling competent to judge if these traps formed an obstruction to the ascent of salmon within the meaning of the law, Lieut. Commander Tanner did not feel justified in carrying out the provisions of the law without further instructions from Washington.

Dr. T. H. Bean, whose letter is inclosed, may be considered as one of the foremost authorities in this country respecting the habits of the Alaskan salmon. He paid special attention to that subject during two official visits to Alaska, the last visit having been made a year ago, in obedience to instructions from Congress contained in the act of which the law now referred to forms a part. In his opinion the building of the traps in Wood River according to the plan submitted by Lieut. Commander Tanner should be regarded as an infringement of the law, and in that opinion I fully concur.

Should you desire to have further instructions respecting this matter sent to Lieut. Commander Tanner, I shall be pleased to transmit the same without delay, although, on account of the imperfect mail arrangements with Unalaska, I fear they may not reach him before the close of the season.

Very respectfully,

M. McDONALD,
Commissioner.

To the foregoing communication the Acting Secretary of the Treasury made the following reply:

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., August 13, 1890.

Hon. MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

SIR: I respectfully acknowledge the receipt of your letter dated July 31, 1890, with the following inclosures:

Copies of two letters from Lieut. Commander Z. L. Tanner, U. S. Navy; one sketch and two blue prints of Wood River, Alaska, and one letter from Dr. T. H. Bean, ichthyologist, U. S. Fish Commission.

The correspondence above mentioned has been carefully reviewed, and you are informed that it is the decision of this Department that the erection of traps as described by Capt. Tanner, or any other permanent fences, dams, or barricades in any of the rivers of Alaska, whether they extend wholly or only in part across said stream, is an impediment to the ascent of salmon or other anadromous species to their spawning-grounds, and is clearly a violation of the act of March 2, 1889.

The Department will be pleased if you will inform Lieut. Commander Tanner of its decision in this case and instruct him to warn the parties who erected said traps, or any others of like nature that may come to his notice, to immediately remove the same, and thereafter to report the persons, with statement of facts, to the United States attorney of Alaska for prosecution under act March 2, 1889, and also to forward a duplicate of his report to this Department for its information.

Respectfully yours,

O. F. SPAULDING,
Acting Secretary.

The following communication was therefore transmitted to Lieut. Commander Tanner, advising him of the ruling of the Treasury Department:

WASHINGTON, D. C., *August 13, 1890.*

Lieut. Commander Z. L. TANNER,
Commanding Fish Commission Steamer Albatross,
Unalaska, Alaska:

DEAR SIR: Your letters of June 15 (179) and 18 (182), relative to your visit to the Nushagak and Wood rivers in respect to reported obstructions to the ascent of salmon, came duly to hand and were referred to the Secretary of the Treasury for his information. In connection with them, I also transmitted to the Secretary of the Treasury a report by Dr. Bean based upon your letters and describing the inevitable effect of the construction of such traps as those now being constructed in the Wood River. A copy of Dr. Bean's report is herewith inclosed, and also a copy of a letter just received from the Acting Secretary of the Treasury, in which a decision is rendered that the Wood River traps are a violation of the act of March 2, 1889.

Should this communication reach you in time you will proceed to carry out the request of the Treasury Department as stated in the letter of the Acting Secretary.

Very respectfully,

M. McDONALD,
Commissioner.

LIMITATION OF THE SALMON CATCH BY AGREEMENT OF THE CANNERS.

The restrictions and embarrassments imposed upon the operations of the canneries by the act of Congress prohibiting the erection of barriers to the ascent of salmon in the rivers, and the decision of the Secretary of the Treasury that the erection of traps or any other permanent fences, dams, or barricades in any of the rivers of Alaska, whether extending wholly or only in part across said streams, was an impediment to the ascent of salmon and other anadromous species to their spawning-grounds, and therefore unlawful, changed the methods and apparatus of the fisheries, but brought no relief or immunity from the threatened disaster, since the methods substituted exclude the salmon from their spawning-grounds as effectually as if permanent obstructions were maintained in the rivers.

The pack of 1891 fell but little short of the enormous pack of 1889, and the accumulated stock of 1889, 1890, and 1891, being in excess of the demands of the market, had its natural result in causing a break in prices, which proved disastrous to many of the canneries and led to a combination of interests for the purpose of reducing production. An agreement to limit the catch was entered into by the canners of Alaska and British Columbia, which was put in operation the present season.

This limitation of the salmon catch by agreement places a check upon excessive fishing in Alaska. The effect will be conservative, although the measure was actuated by selfish motives and may be abrogated at any time when prices recover under the stimulus of increased demand.

Before the opening of the salmon fishery in 1891 it was reported that 600,000 cases of canned salmon were in San Francisco warehouses and that in London about 400,000 cases which had passed into second hands were still on the market. This represents about two-thirds of the total average annual output of the Pacific coast. Finding that the market was overstocked and the price of canned salmon reduced in consequence, so that in many cases business became unprofitable, the canners decided to make a combination and curtail the fishing in the season of 1892. The output of the canneries of Alaska and the Pacific coast canneries for 1891 has been tabulated as follows:

	Cases.
Columbia River	390,000
Other Oregon Rivers	20,000
Puget Sound	20,000
Fraser River	225,000
British Columbia and elsewhere	235,000
Alaska	800,000
	1,680,000

It was expected that the organization of the canners would include those of California and British Columbia as well as Alaska. The first subject of agreement was the reduction of the output to one-half of the usual quantity. By this means the canners hope to improve the trade, especially in the English market. The canners are under heavy bonds to keep the agreement and at the end of the season to declare under oath the amount of their packs. Of the thirty-seven canneries in Alaska only nine will be operated, and the men usually employed in the other establishments will not be hired. The same reduction will be made in California and British Columbia. In Alaska the intention was to operate two canneries at Karluk, two on the Nushagak, one at Chignik Bay, one at Cook Inlet, one either at Loring or Chilkát, one at Alitak Bay, and one at Copper River. The Alaskan output is to be limited to 400,000 cases.

The following agreement was entered into March 25, 1892, between the salmon-canners of Fraser River, Skeena River, Rivers Inlet, and elsewhere in British Columbia:

> Whereas, on account of the overproduction of canned salmon on this coast, the markets of all salmon points in the United States, Canada, and Great Britain are overstocked with canned salmon, and it is desirable in the mutual interests of the parties to this agreement that some limitation in the pack of the coming season should be agreed to, in order that the supply of and demand for that article may be equalized; the several parties hereto have agreed to limit the pack of canned salmon at the canneries owned, controlled, or operated by them and each of them respectively upon the terms and in proportion hereinafter mentioned, as follows, viz: That the reduction in the pack of canned salmon during the season of 1892 shall be upon the Fraser 50 per cent upon the capacity of each cannery, and on the Skeena River and northern points 25 per cent upon the capacity of each cannery.

The salmon-canners on Kadiak Island constitute the following eight companies: The Karluk Packing Company, the Kodiak Packing Company, the Aleutian Island Fishing and Mining Company, the Hume Packing Company, the Arctic Packing Company, the Royal Packing Company, the Russian-American Packing Company, the Alaska Improvement Company.

The capital is upward of $2,000,000. In 1890 they employed 300 men to can 200,000 cases of salmon of 48 pounds each. In 1891 they proposed to reduce the force of men to 160, and still increase the take of salmon. They agreed to employ the same force of fishermen and to appoint a superintendent to see that each day's catch was equally divided among the eight companies. Each cannery was to be allowed the privilege of using private labels as before. The object of this consolidation was not to raise the price of the salmon, but to reduce the cost of taking it, in order to compete with the other thirty canneries and make money. In 1889 three canneries were located on Chignik Bay, and their catch was enough to pay only one, so they employed only one force of fishermen, and the yield in 1890 showed the wisdom of the plan. The title of the association is "The Board of Managers of the Karluk Canning Companies." The president of the board is Leon Sloss, jr., of the Alaska Commercial Company, and the secretary, Leon Maison, of the firm of Geo. W. Hume & Co. The following account of the organization and its operations in 1891 was furnished by Mr. Wm. H. Brommage, of Alameda, California.

Early in 1891 representatives of the various canneries in Alaska held a meeting under the title of "The Board of Managers of the Karluk Canning Companies" with the object of devising means to conduct fishing operations with less expense than usual, intending to put up 250,000 cases. They formed a combination as follows: The Arctic and Kodiak, the Hume and Aleutian Island, the Karluk and Royal, the Alaska Improvement and Russian American.

The pack was to be divided according to the capacity of each cannery; for example: Arctic and Kodiak, $\frac{72}{250}$; Hume and Aleutian, $\frac{35}{250}$; Karluk and Royal, $\frac{85}{250}$; and Alaska Improvement and Russian American, $\frac{45}{250}$. Independent of this, the Kodiak, Russian American, and Royal Packing Companies combined and were to put up fish caught at Little River and Afognak, which was not to be included in the Karluk pack. They employed 61 white men. The larger combination employed 160 men for Karluk, wages $60 for round trip and $12.50 per thousand fish.

Mr. Brommage made inquiry at the headquarters of the Board of Managers of the Alaska Canning Companies on February 24, 1892, and found that 800 men were looking for employment and that only 100 would be engaged, and that only the most experienced of them would be selected. These would be distributed to all the different stations in Alaska. He was informed that only 20 men would be sent to Karluk.

APPARATUS AND METHODS OF THE FISHERIES.

Gill nets, traps, and seines are employed in the capture of salmon, but the greatest bulk of the catch is made by haul seines, which sweep the estuaries of the small rivers, in which the larger part of the salmon catch is made, or are laid out from and landed on the beach proper immediately adjacent to the mouth of the river. One seine follows another in such rapid succession as to cover all approaches to fresh water, and the movement of the salmon into the rivers is as effectually arrested as if permanent barriers were maintained across the entire width of the stream. Gill nets may be used with the same results by stretching them from bank to bank. Traps, indeed, may be so skillfully located in accordance with the habits and movements of the salmon as to form effectual barriers to the upward movement of salmon in the rivers, though invading only in part the channel. Any or all of the different methods here indicated may be employed with such persistence and under such conditions as completely to arrest the movement of the salmon into and up the streams.

The methods at present practiced by the canneries for obtaining a supply of salmon have an influence in bringing about the impoverishment of these important fisheries which can only be understood by a clear apprehension of their relations to the habits and migrations of the species which are the object of the fishery. A separate paper prepared by Dr. T. H. Bean, ichthyologist of the Commission, upon "The Life History of the Salmon," is therefore appended to and made a part of this report. The account of the distribution, migrations, habits, times, and essential conditions of natural reproduction there given will furnish the explanation and reason for such recommendations of further legislation as may be submitted.

SPECIES OF SALMON OF ECONOMIC VALUE.

The species of salmon found in Alaska in quantities sufficient to constitute an economic resource are: The red salmon (*Oncorhynchus nerka*), the king salmon (*Oncorhynchus chouicha*), the silver salmon (*Oncorhynchus kisutch*), the humpback salmon (*Oncorhynchus gorbuscha*), the dog salmon (*Oncorhynchus keta*), the steelhead (*Salmo gairdneri*), and the dolly varden (*Salvelinus malma*).

The Red Salmon.—This species at present constitutes the principal motive and object of canning operations. The southern limit of its range is the Columbia River, in which it is known as the blueback salmon. Its range extends northward to the Yukon River, and it makes its appearance in southern Alaskan waters early in June, the run beginning later as we proceed farther to the north. Schools of salmon continue to arrive until October and, after tarrying a short time in the coast waters, begin to ascend to their spawning-grounds, which are in the cold, snow-fed lakes from which issue the headwaters of the streams which are frequented by this species for the purpose of reproduction. The run is confined chiefly to the smaller streams, such as the Karluk, in which they crowd in numbers absolutely incredible to one who is not an eye-witness, and actually force each other out of the water in their eager struggles to reach the sources of the rivers and deposit their spawn.

The King Salmon.—This is the principal canning species of the Columbia and other rivers of Oregon and California, but at present it has relatively little importance in the Alaskan salmon fisheries. It is distinctively the salmon of the larger rivers, like the Yukon, on which the canning industry has not yet attained much development. It is, however, an abundant species, and with the growth of the canning industry on the larger rivers will attain great commercial importance.

The Silver Salmon.—This species is in great request for canning in the Puget Sound region, but is not held in much esteem by the canners of Alaska, because it becomes soft very soon after its capture and can not be kept like the red salmon. It spawns in the fall of the year, but does not make its appearance on the coast until shortly before canning operations close for the season, and, consequently, the opportunity for natural reproduction is more favorable than for the red salmon or king salmon. The species is abundant now, and under present conditions of the fisheries will doubtless maintain itself. The flesh, though not highly colored, is probably not inferior in table qualities to that of the red salmon, and in the future, with the extension of canning operations, it will doubtless be utilized more extensively than at present.

The Humpback Salmon.—This is the smallest, the most abundant, and most widely distributed species of the Alaskan salmon. It arrives on the coast of Kadiak from the 1st to the 10th of July, and continues to run for about five weeks, the height of the spawning season being early in August. It does not ascend far from salt water, and usually enters streams which are too shallow to cover its back fins. This species is not much used at present for canning purposes, but is dried by the natives in great quantities for winter use, and moderately large numbers are salted for the San Francisco and other markets. When fresh run its flesh is not inferior in edible qualities to that of the red salmon, and has a beautiful red color, but rapidly deteriorates after it enters the estuaries of the rivers. This species, from its abundance and wide distribution, will attain great commercial importance when its good qualities are better known.

The Dog Salmon.—This species occurs very abundantly in the small rivers and creeks of the islands and the main land. It makes its appearance at Kadiak about the middle of June and continues abundant for a month, after which the numbers rapidly diminish. It leaves the coast with the first appearance of ice. The flesh of this species will hardly ever be in request for canning, but it is one of the most important species to the natives, who dry it for winter use.

REPRODUCTION AS RELATED TO METHODS

The species of salmon above enumerated, though differing in their seasons of reproduction and in their spawning habits and requiring different conditions and environment, are all subject to the restraint of one common law: they must have access to their natural spawning-grounds in the rapids of the rivers or in the cold, snow-fed lakes from which they issue; and in this natural law is to be found the suggestion of such legislation as may be necessary "to maintain the salmon fisheries under permanent conditions of production."

Whether these fisheries shall continue to furnish the opportunity for profitable enterprise and investment depends upon the policy to be inaugurated and maintained by the Government. Under judicious regulation and restraint they may be made a continuing source of wealth to the inhabitants of the Territory and an important food resource to the nation; without such regulation and restraint, we shall have repeated in the Alaskan rivers the story of the Sacramento and the Columbia; and the destruction in Alaska will be much more rapid because of the small size of the rivers and the ease with which salmon can be prevented from ascending them. For a few years there will be wanton waste of that marvelous abundance, which the fishermen concerned only for immediate profit and utterly improvident of the future declare to be inexhaustible. This season of prosperity will be followed by a rapid decline in the value and production of these fisheries, and a point will be eventually reached where the salmon-canning industry will be no longer profitable.

PROTECTIVE REGULATION OF THE FISHERIES

Whatever may be the particular regulations and requirements it shall be found necessary to impose in the prosecution of the salmon fishery in order to maintain the supply, it is essential they should provide either that a considerable proportion of the run into the rivers shall be permitted to pass up and accomplish natural reproduction in the lakes and tributary streams which afford feeding grounds for the young salmon during the period of their sojourn in fresh water, or that artificial propagation of the young and their distribution to the headwaters of the streams shall be prosecuted on a scale adequate to compensate for the interference with and the curtailment of natural reproduction by the operation of the fisheries.

If it be the policy of the Government to depend upon natural reproduction to maintain supply, this can be made effectual only by the enactment and enforcement of such regulation of the fisheries as will assure adequate reproduction under natural conditions. The different agencies which may be invoked, either separately or in conjunction, to accomplish this end are:

(*a*) A weekly close season from Saturday evening to Monday morning.
(*b*) A close season during September and October of each year.
(*c*) The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone.
(*d*) Absolute prohibition of the capture of salmon by the use of nets or other apparatus within 100 yards of the mouth of any river.
(*e*) The prohibition of the use of more than one seine in the same seine berth.
(*f*) The leasing of the privilege of taking salmon and the limitation of the catch, in accordance with the recommendation of the Commissioner of Fish and Fisheries, based upon continued and careful investigations of the conditions of the fisheries.

The establishment of a weekly closed season will assure that some proportion of the run will succeed in reaching their spawning-grounds, will of course have a conservative influence in keeping up supply, will render slower the depletion of the waters, and will probably prevent the extermination of the salmon.

The establishment of a close season during September and October will permit the schools of salmon approaching the coast during this period to enter the rivers and spawn unmolested. The conservative influence of this measure will depend of course upon the number of salmon which approach the coast only after the opening of the close season.

The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone in a paper read before the American Fisheries Society, would be an important factor in maintaining production and could be accomplished with relatively little cost. The importance of this agency as a means of maintaining the supply is so interestingly and forcibly presented by Dr. Stone in the article referred to that it is deemed appropriate to reproduce it here as published in Forest and Stream of June 16, 1892:

A NATIONAL SALMON PARK.

[A paper read before the American Fisheries Society.]

Who would have thought thirty years ago that the creation of a national park in this country would be the means of rescuing the buffalo from extinction? Who thought then that anything was needed to rescue the buffalo? The buffalo roamed in myriads over the plains and mountain slopes of the central portions of the United States and were so innumerable that, with the exception of a few far-sighted persons, no one thought that this noble race of animals was even in danger. The supply seemed inexhaustible and the species at least safe from extinction.

How soon we found out our mistake and how suddenly the change came. The note of alarm had hardly been sounded long enough to be distinctly comprehended over the country before the buffalo were gone—all gone practically, except a few straggling survivors which, if they had not found refuge in Yellowstone Park, would have been gone, too, long before this. The Yellowstone National Park saved them. It saved the wild race from extinction, and, if nothing else should ever be accomplished by the creation of the park, this alone would, in the writer's estimation, justify its existence.

But if any one had said thirty years ago, "Let us form a national park in the buffalo region for a protection and refuge for the buffalo," the proposition would have been laughed down from one end of the country to the other. It would have been thought a most ridiculous expedient, a scheme too foolish and crazy to be even seriously entertained. Nevertheless, the creation of the National Park has accomplished this very object, and has been, I think it may be safely said, the only means of accomplishing this most important object, the preservation of the American buffalo.

Now what this paper is going to propose will appear, doubtless, just as ridiculous, just as foolish and crazy, as the formation of a park for the preservation of the buffalo would have been thought thirty years ago. It is nothing less than the creation of a national park for the preservation of our salmon.

I hear already from all directions the question "What do the salmon need a park for? Are there not plenty of places of safety for them already in all the rivers and streams of this country, not to mention the pathless ocean, where man can not follow them?"

It looks so at first sight, I admit; but let us try to find these places of safety if they exist, and then see how it looks. We certainly can not find them on the Atlantic coast, where the scanty yield of the only two American salmon rivers—the Kennebec and the Penobscot—is only a drop in the bucket compared with the total consumption of salmon. Passing over to the Pacific coast we find only the Sacramento, the Columbia, and the lesser streams on the Washington and Oregon coast, and in all these the salmon are about as safe as the fur seals were last year in Bering Sea.

I will say from my personal knowledge that not only is every contrivance employed that human ingenuity can devise to destroy the salmon of our west-coast rivers, but more surely destructive, more fatal than all is the slow but inexorable march of those destroying agencies of human progress, before which the salmon must surely disappear, as did the buffalo of the plains and the Indian of California. The helpless salmon's life is gripped between these two forces, the murderous greed of the fishermen and the white man's advancing civilization, and what hope is there for the salmon in the end? Protective laws and artificial breeding are able to hold the first in check, but nothing can stop the last.

To substantiate this statement, which may seem exaggerated, let me inquire what it was that destroyed the salmon of the Hudson, the Connecticut, the Merrimac, and the various smaller rivers of New England, where they used to be exceedingly abundant? It was not overfishing that did it. If the excessive fishing had been all there was to contend with, a few simple laws would have been sufficient to preserve some remnants at least of the race. It was not the fishing, it was the growth of the country, as it is commonly called, the increase of the population, necessarily bringing with it the development of the various industries by which communities live and become prosperous. It was the mills, the dams, the steamboats, the manufactures injurious to the water, and similar causes, which, first making the streams more and more uninhabitable for the salmon, finally exterminated them altogether. In short, it was the growth of the country and not the fishing which really set a bound to the habitations of the salmon on the Atlantic coast.

Let me illustrate this same statement more in detail by presenting the testimony of the salmon rivers of the Pacific coast. Take for an example the Sacramento. When the first rush of gold-seekers came to California in 1849, every tributary of the Sacramento was a fruitful spawning-ground for salmon, and into every tributary countless shoals of salmon hastened every summer to deposit their eggs. When the writer went to California in 1872, only twenty-three years later, not one single tributary of the Sacramento of any account was a spawning-ground for the salmon except the McCloud and Pitt rivers in the extreme northern part of the State, where the hostility of the Indians had kept white men out. It was not fishing by any means that had caused the disappearance of the salmon, for the miners did very little fishing in those times; but it was the débris from the quartz mines which drove the salmon out, ruining the spawning-grounds and rendering the river uninhabitable for the salmon.

This was in 1872. In 1878 the writer took 14,000,000 of salmon eggs from the summer run at the United States salmon station on the McCloud River. In 1883 the Southern Pacific Railroad Company (then the Central Pacific) extended their line northward up the Little Sacramento, crossing the mouth of Pitt River, into which the McCloud empties, a mile or two above.

So disastrous to the salmon was the effect of the road building along the Little Sacramento and the mouth of the Pitt that that year it was with great difficulty and only by very hard work that we succeeded in getting barely 1,000,000 salmon eggs, and the next year Prof. Baird, in disgust at what he considered the unpardonable indifference of the Californians, discontinued taking salmon eggs at this station. Since that time sawmills of immense capacity have been erected at the head of the Little Sacramento and the McCloud, and have done very effective work in increasing the now alarming scarcity of the spawning salmon of the Sacramento.

I think these instances are sufficient to show that what the friends of the salmon have to fear more than overfishing is the growth or development of the country always attendant upon an increasing population, but the fatal consequences of which to the salmon it is impossible to avoid. Nothing can stop the growth and development of the country, which are fatal to the salmon. For instance, there was no power in the world that could have prevented the mining on the Feather, the Yuba, the American Fork, or the other spawning streams of the salmon; nothing could have stopped the building of the railroad up the Little Sacramento or the erection of the sawmills on the upper McCloud. They came along naturally and inevitably in the march of events, and they could not be withstood; and nothing was left for the salmon but to suffer the consequences and disappear as by a decree of fate.

Now actual fishing in the salmon streams can be regulated by law and rendered comparatively harmless, but the country will continue to grow more and more populous, and the fatal march of civilization will proceed as irresistibly as ever. That can not be held back, and unsafe as the salmon are now in our Atlantic and Pacific coast rivers, they will become more and more unsafe every year; all of which goes to show that there is no safe place for the salmon within the limits of the United States proper.

This leaves us only Alaska. Now, how is it with the salmon streams of Alaska? Not even there are the salmon safe. Countless myriads of salmon formerly filled all the rivers and streams of the long Alaskan coast, and they were nearly 2,000 miles from the destroying hand of civilized man, but they were not safe even on those distant shores. The ubiquitous canneryman found them, and he already has his grip on the best and most fruitful of the Alaskan rivers. The pressure of the world's demand on the world's supply of canned salmon renders it necessary for the salmon-canner to occupy more distant and less fruitful fields every year, and it is only a question of time when all the Alaskan salmon streams are given over to the canneries, and when that time comes no one will claim, I think, that the salmon are safe in Alaska.

One or two illustrations are sufficient. The Karluk River, on Kadiak Island, is probably the most wonderful salmon river in the world. On August 2, 1889, the cannery nets caught on Karluk Beach, at the mouth of the river, 153,000 salmon by actual count. A short time after, the writer went up the Karluk River in a bidarka—the skin boat of the natives—expecting to see myriads of salmon spawning and thousands on their journey to the spawning-grounds, but instead of the wonderful sight we anticipated, our whole party, I think, saw less than a dozen in the river till we reached the lower spawning-grounds, and then, to our astonishment, we saw only a few scattering fish spawning, such as one might expect to see in the most commonplace salmon river in the world; 153,000 salmon caught in one day at the mouth of the river, and none to speak of going up the river to reproduce their species. Every one can draw his own inference. The fact is significant enough.

On another river, a large one, the Nushagak, where vast numbers of salmon were taken at the mouth one summer for canning, we were told that the succeeding winter the natives living up the river were brought to the verge of starvation because the salmon which they had always depended on for their winter's food were so scarce. Of the thousands and thousands of salmon that usually ascend the river to spawn, not enough spawners escaped the nets at the mouth to keep the natives on the upper waters from starving. This fact speaks for itself also.

So much for the safety of salmon in Alaska in general, but it would yet seem that on the uninhabitable shores of the Arctic Ocean the salmon might find a place of refuge; but not even there can they stay unmolested, for parties were planning three years ago, the writer was told, to establish canneries on the affluents of the frigid and forbidding Arctic. So we see that our salmon are not safe even in Alaska, their last refuge, and if not there, they are not safe anywhere within the limits of our broad land.

But now the question comes up, "Will not protective laws and artificial breeding make the salmon secure enough?" My answer is that good laws and artificial breeding will do a good deal toward it, but not enough. Good laws can prevent overfishing, but no laws can arrest the encroachments on the salmon rivers of increasing populations and their consequent fatal results to the salmon. No laws could possibly have been enacted which for instance would have stopped the manufacturing enterprises on the Connecticut, or the vast water traffic of the great metropolis at the mouth of the Hudson, which doubtless drove the salmon out of these rivers. Protective laws may regulate the salmon fishing of the Sacramento, but no laws can stop the mining, the logging, and the railroad building that are destroying the spawning-grounds of the tributaries of the Sacramento. It is not in the power of law enactments to save the salmon from all their dangers.

Artificial breeding can do a great deal, and has done a great deal, but it can not be relied upon for a certainty. In the first place, it is very uncertain where one can find a suitable place for hatching salmon. The writer traveled over 4,000 miles up and down the Columbia and its tributaries, from the Continental Divide to the Pacific coast, looking for a good place for salmon hatching, first in 1877 for the Oregon and Washington cannery men, and afterward in 1883 for the U. S. Fish Commission, and found only two places in that great stretch of country which were suitable; one on the Clackamas River, where the writer built a hatching station, and the other on the Little Spokane, a few miles from Spokane Falls, which is still unoccupied.

There is in all the great State of California but one stream suitable for salmon hatching on a large scale, and on this stream, strange as it seems, there is but one spot that meets all the requirements of the case, and that is the place that the writer selected and built upon on the McCloud River in 1872, and named Baird, in honor of the distinguished Commissioner under whose direction the work was done. Allow me to add by way of confirmation that subsequently the State fish commissioners of California, after hunting all over the State for another place for hatching salmon, have given it up, and now get their supply of salmon eggs from the Government station at Baird.

The above instances illustrate the difficulty of finding suitable places for hatching salmon on a large scale; and not only is it not easy to find such places, but they can not be relied on to a certainty when they are found, for they are always in danger from logging, mining, railroad building, lumber manufacturing, and other causes, which yearly become more imminent and dangerous as the country gets settled up and the population increases, and which threaten at any time to destroy their efficiency.

We must come to the conclusion, then, that even with the help and support of protective laws and artificial breeding, our salmon, like the buffalo of thirty years ago, are not safe. The destroying agencies of advancing civilization drove the buffalo to the last ditch, so to speak, and then the last survivors, or almost the last, were slain. They were obliged from sheer necessity to come to feed where from all directions the hand of man was raised against them. Whether they turned to the north or to the south, to the east or to the west, they went to their certain death, and in an incredibly short space of time they practically disappeared.

The story of our salmon is analogous. They are obliged to come inland to breed. They are compelled from sheer necessity to come up the rivers into the very midst of their human enemies. They can not stay in the ocean like other fishes of the sea, where they are safe from the hand of man, but they must necessarily come, one might say, into his very grasp, and, like the buffalo, whether they turn to the north, south, east, or west they go into the very jaws of death; for what hope is there for a salmon to escape after he has entered a river, if man chooses to employ his most effective agencies for his capture? There is none. The salmon is doomed. There is no altar of refuge for the salmon in this country any more than there was for the buffalo.

Ought not something to be done then? Ought this state of things to continue? The salmon of the United States are one of our most valuable possessions. As a matter of ordinary prudence, ought not the country to have some place, if it is possible, where the salmon can come and go in safety? If a stock-raiser saw that his cattle were daily diminishing because they had no spot where they were safe from beasts of prey, what kind of man should we think he was if he did not very soon fix a place where they would be safe? We should, to draw it mildly, think he was very improvident and negligent. Is it any less improvident and negligent for this country not to provide a place for its rapidly diminishing salmon where they will be safe? It seems to the writer that not a day ought to be lost, but that if it is possible to provide a place where our salmon can resort unharmed and remain safely their allotted time, it should be given them without hesitation. If there is such an asylum of refuge within our borders, by all means secure it for the salmon and let the salmon have it for an eternal heritage.

Is there such a place within the limits and jurisdiction of the United States? The writer can say from personal knowledge that there is one place at least. Most fortunately for us Americans there is in our Alaskan possessions just such a place as is wanted—probably more than one—and so exceptionally fortunate is America in this respect that it is not likely that this side of the frozen and uninhabit able shores of the Arctic it can be duplicated many times in the possessions of all the nations of the earth combined, which significant circumstance, allow me to add in passing, goes to show how near the world has reached the extreme limit of its salmon supply.

The locality which the writer has in mind is an island in the North Pacific about 750 miles nearly due west of Sitka. Its name is Afognak, and it is the northernmost of the two largest islands of the group called the Kadiak Islands. It lies just north of latitude 58° and between 152° and 153° west longitude. It is a small island, probably not over 50 miles across at its widest part, but there are several streams flowing from various points of the island to the surrounding ocean that at the proper season contain salmon innumerable. It is no exaggeration to say that salmon swarm up these streams in countless myriads. When the writer was on the island in 1889 the salmon were so thick in the streams that it was absolutely necessary in fording them to kick the salmon out of the way to avoid stumbling over them. I know that this story is an old salmon chestnut, but it illustrates as well as anything the wonderful abundance of salmon in the Afognak streams; and it can be easily believed when it is remembered that about a month earlier 153,000 salmon were caught in one day at the mouth of the Karluk, which is a river only 60 feet wide where it empties into the ocean. But there is no need of consuming time in proving the abundance of salmon at Afognak Island. It is a matter of record. The salmon are there in as great numbers as could be wished. All the varieties also which inhabit the Pacific Ocean come to Afognak. The list is as follows; it is a royal catalogue:

1. The red salmon, the "blueback" of the Columbia (*Oncorhynchus nerka*).
2. The king salmon, the "quinnat" or "spring salmon" of the Columbia (*O. chouicha*).
3. The silver salmon, the "silversides" of the Columbia (*Oncorhynchus kisutch*).
4. The humpback salmon (*Oncorhynchus gorbuscha*).
5. The dog salmon (*Oncorhynchus keta*).
6. The steelhead, the "square-tailed trout" of the tributaries of the Columbia (*Salmo gairdneri*).
7. The dolly varden (*Salvelinus malma*).

It is easy to see what a paradise for salmon this island is, and what a magnificent place of safety it would be if it were set aside for a national park where the salmon could always hereafter be unmolested. But the abundance and variety of its salmon are not the only recommendations that Afognak Island has for a national park. It has several others, which may be enumerated as follows:

1. The island is inhabitable all the year round, with a comparatively even temperature. Although so far north, the winter's cold is not excessive, probably not equaling that of parts of New England. It is cooler than New England in summer, it is true, but there is much less variation of temperature between summer and winter.

2. The rivers of Afognak still exist in all their original purity and fruitfulness. No overfishing has left them barren. No mills have polluted their primeval purity. No railroads have frightened the salmon away from them. No mining has disturbed their native spawning-grounds. As salmon rivers they are still in their original glory. To quote a not inappropriate line of Byron, "Such as Creation's dawn beheld" them, they are rolling now. Consequently, nothing need be done nor any expense incurred in putting the rivers in order for asylums of refuge for the salmon.

3. No complications now exist or can come up in future in regard to land titles in the island. The United States Government owns the land already, like the rest of Alaska, by direct purchase from Russia, and has never parted with any of its exclusive rights of ownership. No State or Territory or company or individual owns an acre of it. Consequently the United States Government can set aside the island for any purpose whatever, without interfering with any prior rights or titles, or incurring any risk of litigation.* Alaska is already one great reservation.

4. The island will probably never be wanted for anything else. The summer season is so short that no crops can be raised there, and it is not likely that for many generations, if ever, the land will be wanted by permanent settlers, and it is now inhabited only by a few Aleuts and half-breed families who would not be interfered with. There would be no injustice done to individuals by making a reservation of the island.

5. Last but not least, artificial hatching can be instituted there at any time, if it is ever thought best, and on a vast scale if desired; and unlimited numbers of the eggs of the various kinds of salmon noted above can be obtained for distribution and sent to all other parts of the country where they may be needed.

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* There are two canneries operating in the southern part of the island, but there would probably not be great difficulty in making satisfactory arrangements with them.

The above considerations seem to indicate that Afōgnak Island possesses all the qualifications required for a place of safety for our Pacific Ocean salmon without presenting any objections to its being reserved by the Federal Government for salmon, or in other words converted into a national salmon park.

The writer, however, would not urge the claims of Afōgnak or any other place to this distinction as against those of any locality that may be found to be better fitted for it. This island has been brought forward merely as showing that one place at least is known that would answer the purposes of a salmon park. There are doubtless others in our Alaskan possessions. There are possibly better ones. If a better place can be found, let us take it. If not, let us take Afōgnak Island; but at all events let some place be selected and set aside by the authority of the National Government. If not Afōgnak Island, let it be some other place. Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impracticable, or at least very difficult. Now is the time. Delays are dangerous. Some unforeseen difficulties may come up which we do not dream of now, any more than we did a few years ago of logging on the Clackamas or railroad building on the upper Sacramento.

If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon are gone they can not be reclaimed. Exaggerated as the statement seems, it is nevertheless true that all the power of the United States can not restore the salmon to the rivers after the work of destruction has been completed. The familiar nursery rhyme about the egg applies here with peculiar fitness:

"Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses and all the king's men
Could not set Humpty as before."

That is the whole thing, so to speak, in an eggshell. After the salmon rivers are ruined all the king's horses and all the king's men, that is to say, all the power of the Government "can not set them as before."

Let us act then at once and try to do something for the salmon before it is too late. Dangerous complications may come suddenly upon us which we can not foresee. How little we foresaw the danger to the buffalo and the fur seals. How suddenly the disastrous results came. Even if not impracticable, it may cost large sums of money to do hereafter what may be done now for nothing. No expense need be incurred at present. All that is required is to have Afōgnak Island or some other suitable place set aside by national authority, as Gen. Grant set aside the McCloud River Reservation during his administration, and it can be left to future events to decide whether it is expedient to expend any money on the reservation, a subject that can be safely left, we all know, in the hands of our efficient Commissioner of Fish and Fisheries. There seems to be no impropriety in the United States having a national salmon park, but on the contrary it appears eminently proper that a great natural salmon country like ours should have set apart some safe repository and fruitful breeding-grounds for this noble fish.

Consider for a moment what the salmon has done for us, and then think how mercilessly we have treated him. Our salmon has been to us a source of national revenue, enjoyment, and pride, and what return have we meted out to him? He has been hunted pitilessly with hooks and spears, with all kinds of nets and pounds, with wheels and guns and dynamite, and there is not a cubic foot of water in the whole country where he can rest in safety. The moment he comes in from the ocean he meets the gill nets and the pounds at the mouth of the river, the sweep seines further up, the hook everywhere, and at last on his breeding-grounds, which at least ought to be sacred to him, he encounters the pitchforks of the white man and the spears of the Indian.

Let us now, at the eleventh hour, take pity on our long-persecuted salmon and do him the poor and tardy justice of giving him, in our broad land that he has done so much for, one place where he can come and go unmolested and where he can rest in safety.

Allow me to add in closing that it seems to me highly appropriate that this society, which represents with such intelligence and ability all the fishing interests of every kind of this country, should take the initiative in a matter in which those interests are so closely concerned. The writer trusts that it will, and ventures to predict that, if its efforts in that direction should happily be rewarded by the creation of a national salmon park, it would become an enduring monument to the usefulness of the society that would last as long as the nation lasts.—LIVINGSTON STONE.

Absolute prohibition of the capture of salmon by the use of any kind of nets or traps within 100 yards of the mouths of the rivers would assure that some proportion of each run of salmon would succeed in entering the streams and reach the spawning-grounds.

The prohibition of the use of more than one seine in the same berth would prevent that actual and effective obstruction of the approaches to the rivers which is now accomplished by the use of seines in pairs sweeping the same area, and succeeding each other so continuously as to capture every fish coming within the seine berth.

The above requirements, reasonably and uniformly enforced, would probably be sufficient to maintain regular conditions of production and render permanent this great food resource. Should they be supplemented by recourse to artificial propagation on an adequate scale, it will be possible not only to maintain the present supply, but probably greatly to increase the annual production. The enforcement of the regulations and requirements, above indicated, would, however, demand constant and minute supervision and the employment of a large personnel and a difficult administration.

It is believed that better results and more satisfactory administration could be accomplished by limiting the catch in each stream to its actual productive capacity under existing conditions, and by leasing the privileges of taking the salmon to the highest bidders. The lessees of any river would see that there was no trespassing upon privileges for which they paid. The limitation of the catch being kept safely within the natural productive capacity of the stream, greater care would be exercised by the canners, the quality of the products would be improved, and stability of prices assured by reason of the fact that the total production would be approximately known in advance of the season.

The number of cases packed would be a matter of easy and accurate ascertainment by the Government agent charged with that duty. Should the funds obtained from the lessees be applied first to the administration of the regulations of the fishery, and the balance devoted to systematic fish-culture, it is probable that the revenues from these fisheries will not only suffice for their rational management, but will permit and provide for such extensive fish-cultural operations as will not only maintain present conditions and production, but also greatly increase the annual output.

Very respectfully,

MARSHALL MCDONALD,
Commissioner.

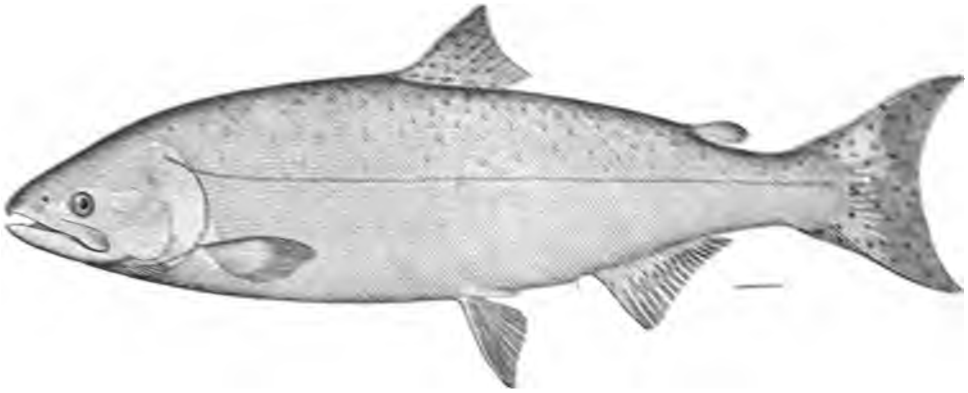


FIG. 1. THE KING SALMON (*Oncorhynchus tschawytscha*).

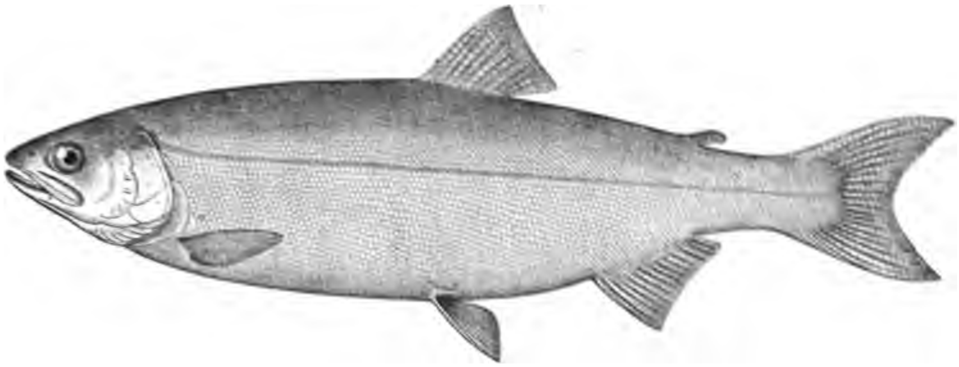


FIG. 2. THE RED SALMON (*Oncorhynchus nerka*). Sea run.

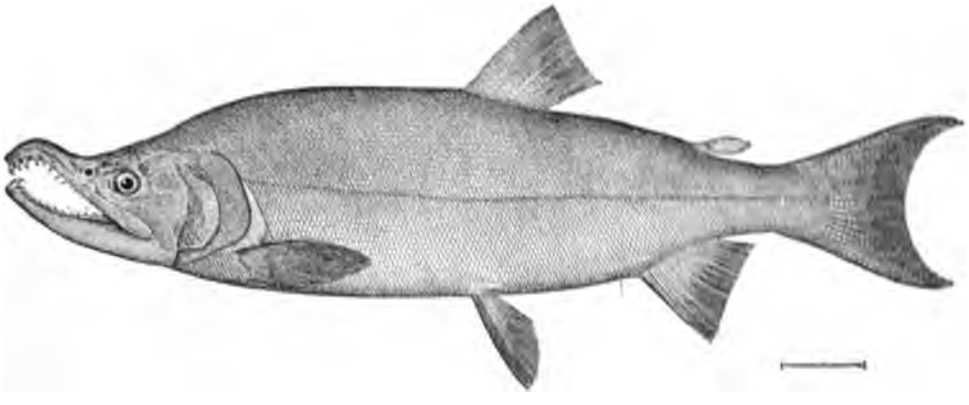


FIG. 3. THE RED SALMON (*Oncorhynchus nerka*). Breeding male.

Bull. U. S. F. C. 1892. Salmon Fisheries of Alaska. (To face page 20.) **PLATE III.**

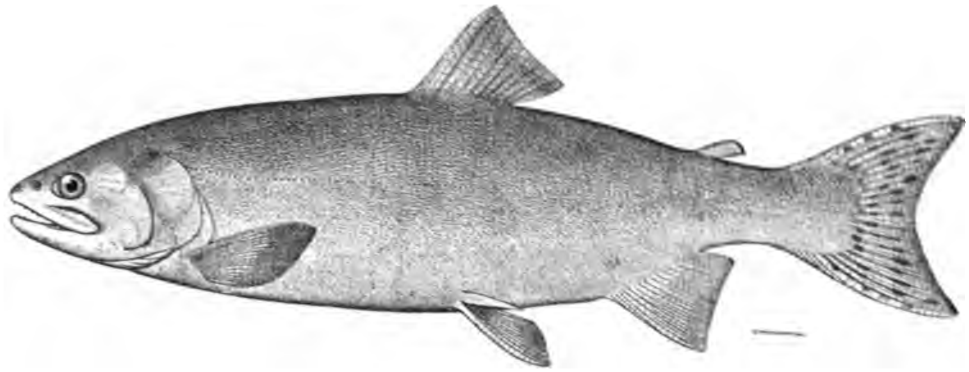


FIG. 1. THE HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Sea-run.

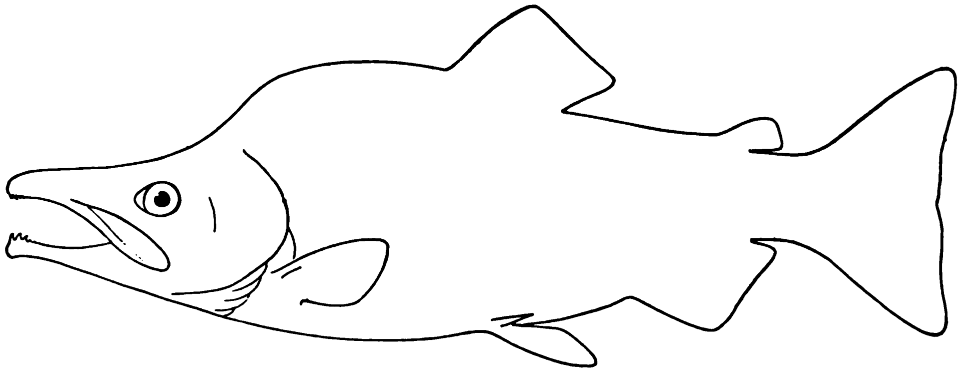


FIG. 2. THE HUMPBACK SALMON *Oncorhynchus gorbuscha*). Breeding male.

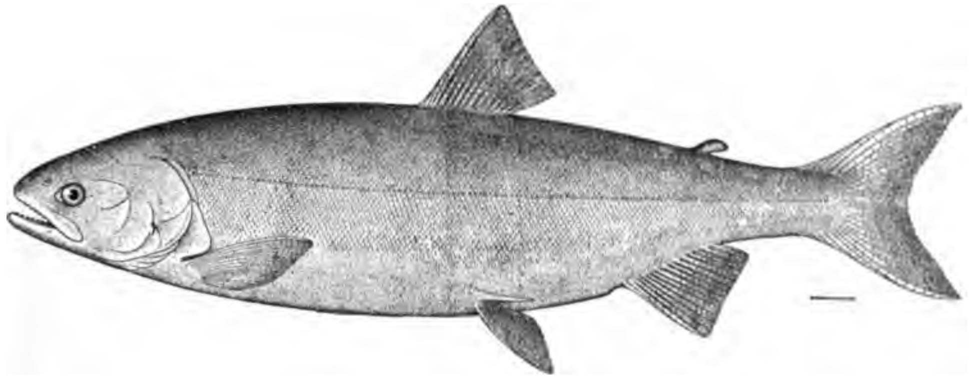


FIG. 3. THE DOG SALMON (*Oncorhynchus keta*).

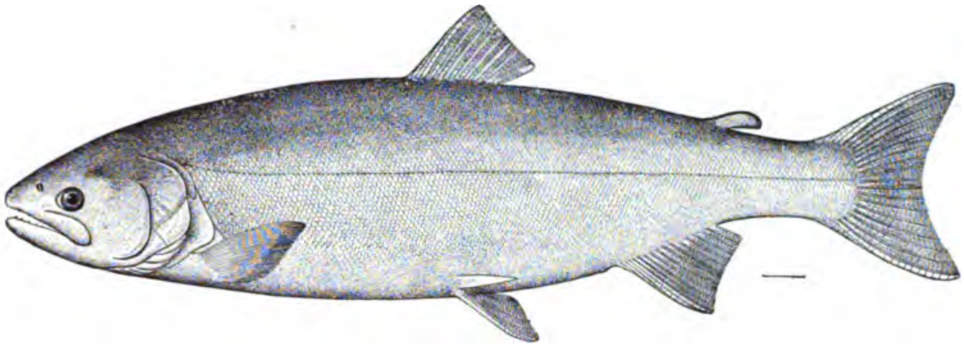


FIG. 1. THE SILVER SALMON (*Oncorhynchus kisutch*).

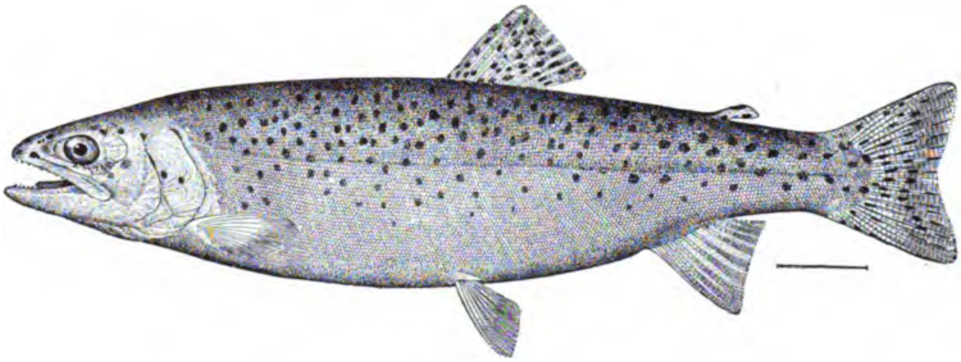


FIG. 2. THE RED-THROATED TROUT (*Salmo mykiss*). Adult.

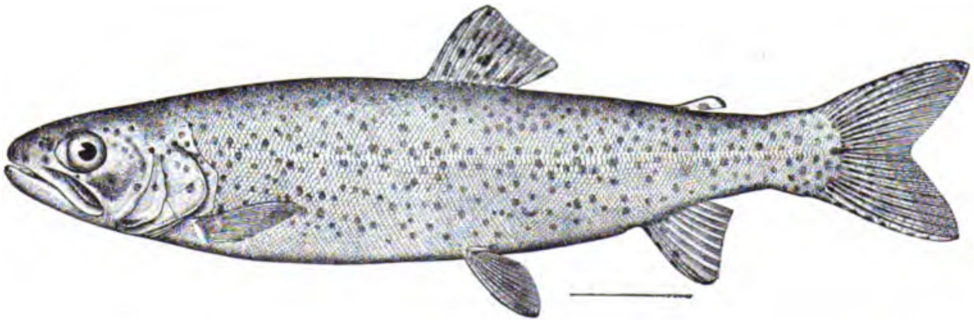


FIG. 3. THE RED-THROATED TROUT (*Salmo mykiss*). Young.

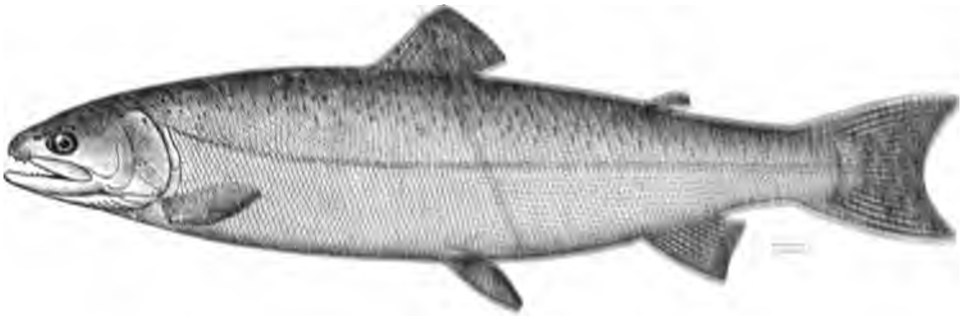


FIG. 1. THE STEELHEAD (*Salmo gairdneri*). Adult.

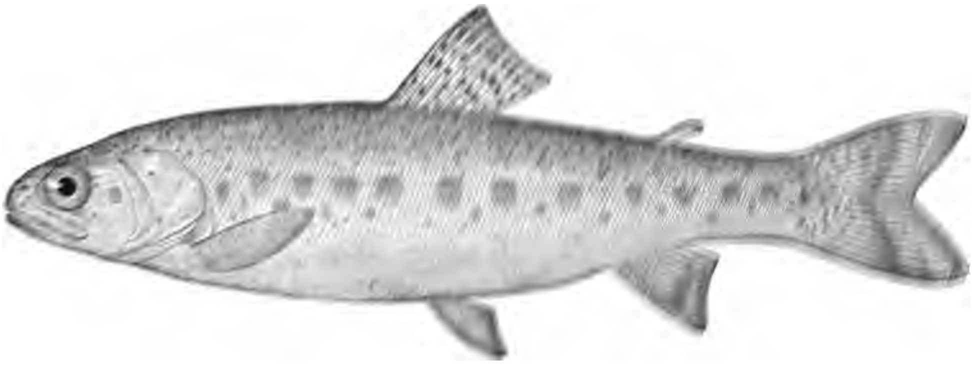


FIG. 2. THE RAINBOW TROUT (*Salmo irideus*). Young.

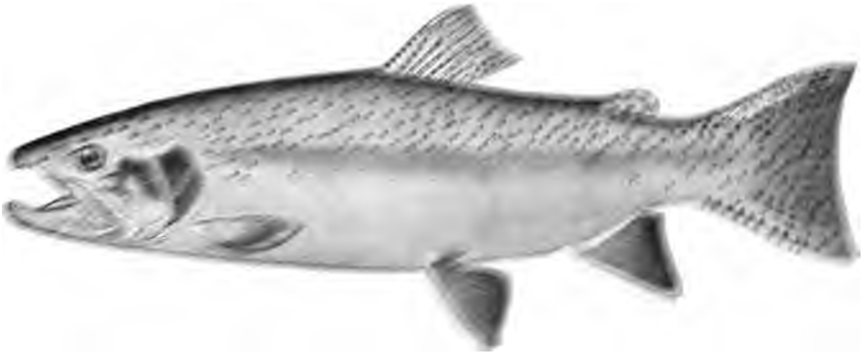


FIG. 3. THE RAINBOW TROUT (*Salmo irideus*). [illegible]

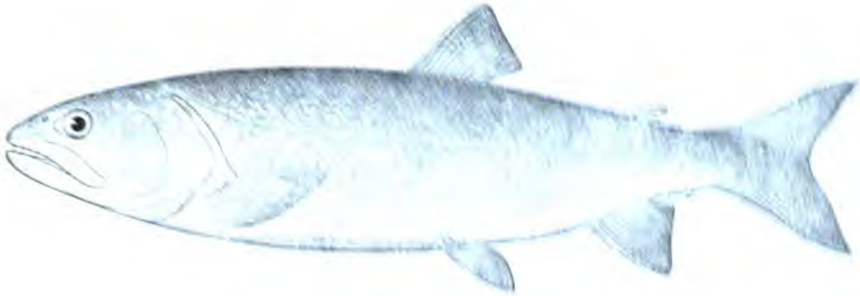


FIG. 1. THE LAKE TROUT (*Salvelinus namaycush*).

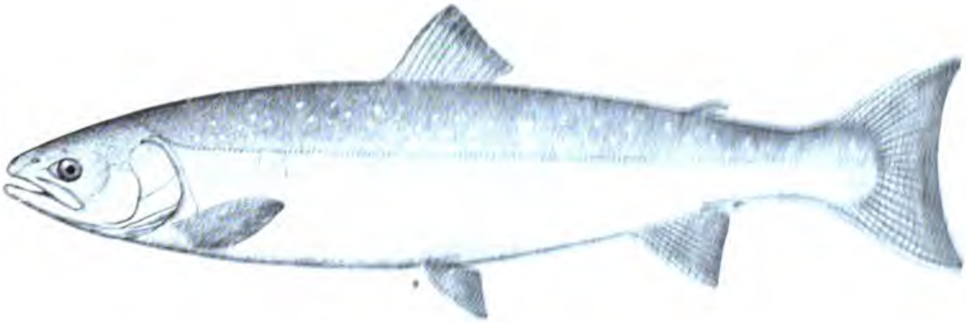


FIG. 2. THE DOLLY VARDEN TROUT (*Salvelinus malma*).

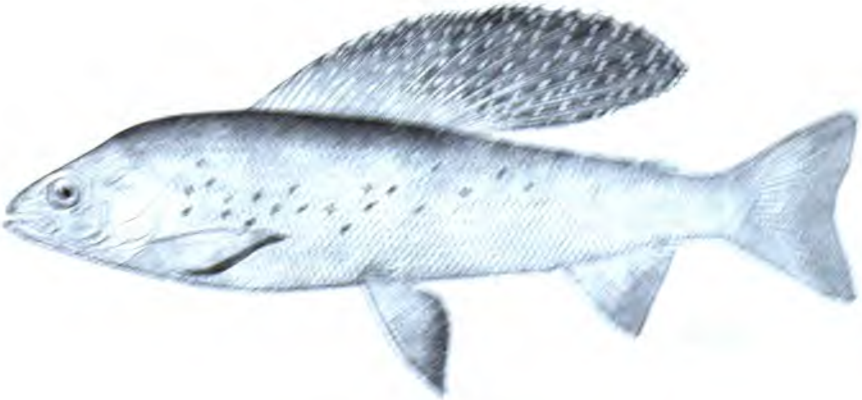
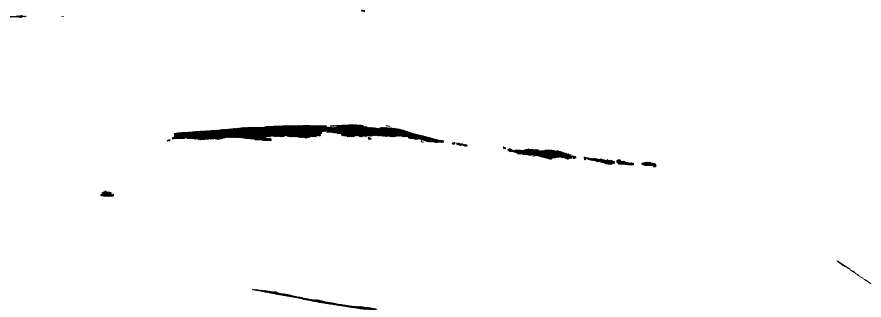


FIG. 3. THE ALASKA GRAYLING (*Thymallus signifer*).



[illegible]

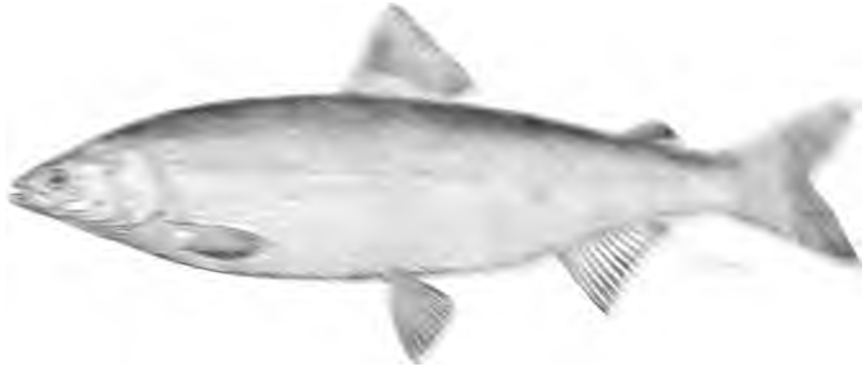


Fig. 2. The [illegible]

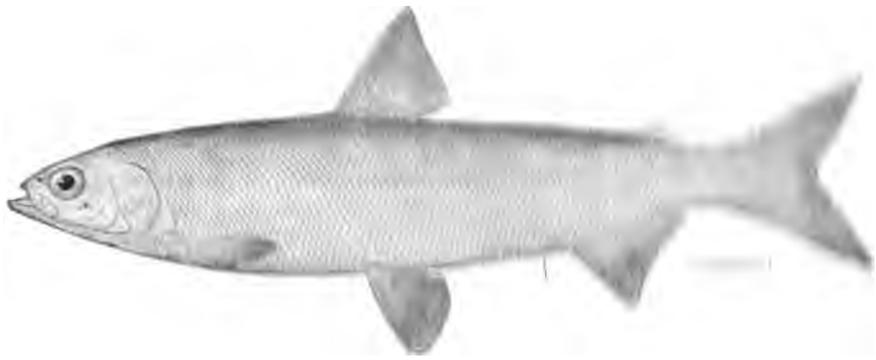


Fig. 3. The Small Whitefish [illegible]

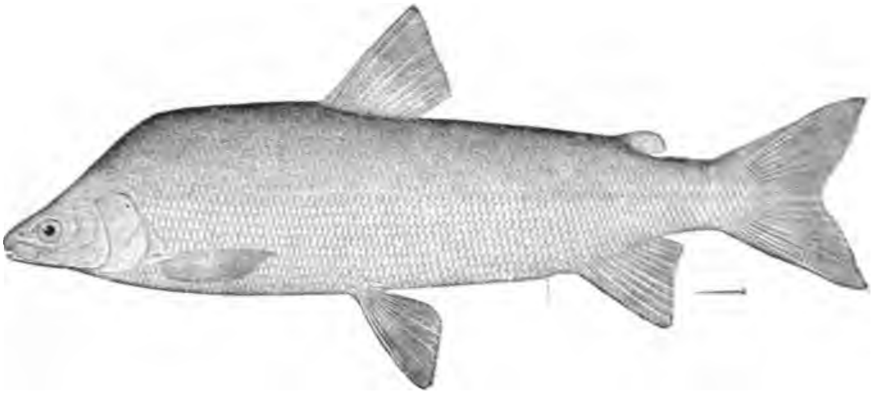


FIG. 1. NELSON'S WHITEFISH (*Coregonus nelsoni*).

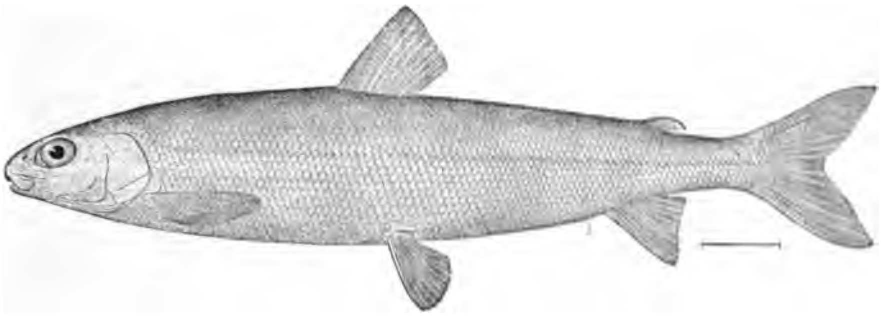


FIG. 2. THE ROUND WHITEFISH (*Coregonus quadrilateralis*).

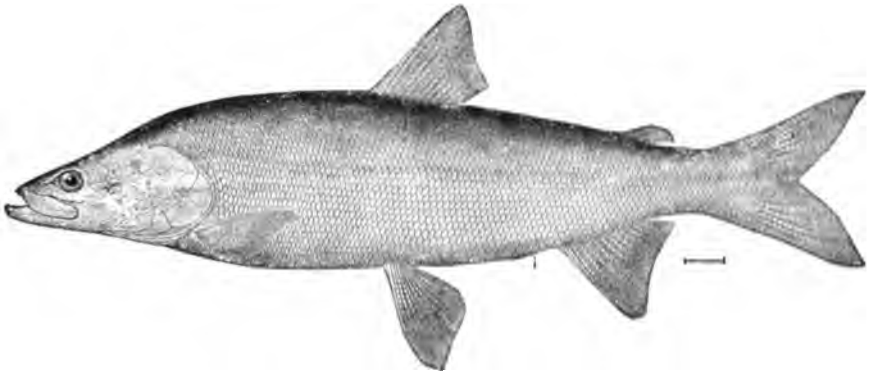


FIG. 3. THE INCONNU (*Stenodus mackenzii*).

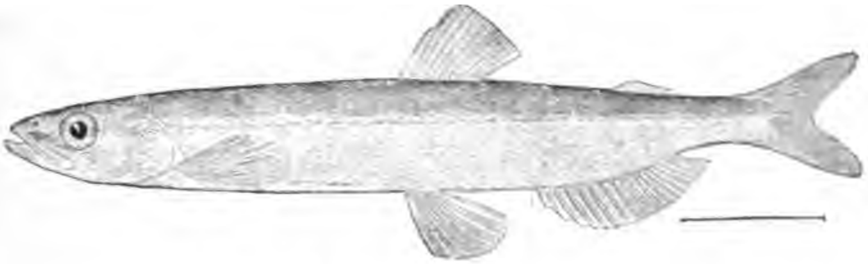


FIG. 1. THE CAPELIN (*Mallotus villosus*).

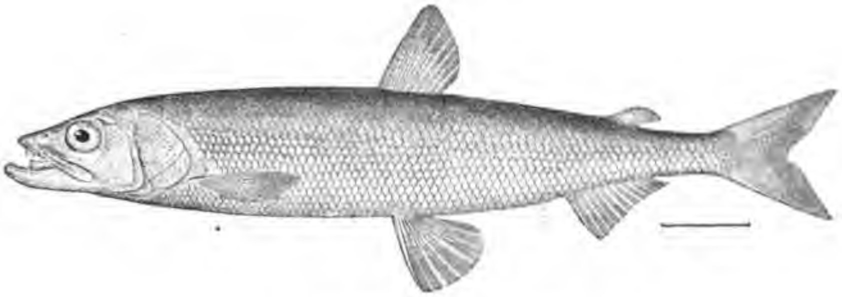


FIG. 2. THE SMELT (*Osmerus dentex*).

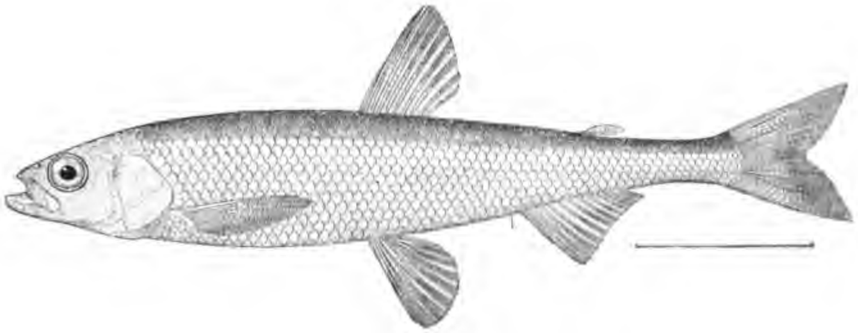


FIG. 3. THE SURF SMELT (*Hypomesus olidus*).

LIFE HISTORY OF THE SALMON.

BY TARLETON H. BEAN, M. D.,
Ichthyologist, U. S. Fish Commission.

The greatest wealth of Alaska is represented by its fishes, and among these by far the most important are the members of the salmon family and other closely related forms, such as the whitefishes, grayling, smelt, and capelin. The salmon alone represent an annual value for canning purposes of about $3,000,000, derived almost entirely from three species. The undeveloped resources which may be obtained from the salmon-like fishes have undoubtedly equal importance with the material now utilized.

In the distribution of the *Salmonidæ* Alaska received a generous share. Seventeen of the known species, or about one-sixth of the entire number, occur in its waters. Lying entirely within the area in which the family is indigenous, plentifully supplied with long water-courses, rapid snow-fed streams, and cool, deep lakes glistening in mountain valleys, over beds of clean gravel and bowlders intermingled with sheltering water plants, free from obstructions to the movements of the migratory species, its invitation to the salmon to come in and possess the waters and multiply therein was readily accepted.

The largest salmon of the world are credited to this Territory, and there is no doubt that in Cook Inlet king salmon which weigh over 100 pounds are occasionally taken, but this is far above the average weight of the species. The most abundant salmon in Alaska are the red salmon and the little humpback, and it is these species which figure in the wonderful tales concerning rivers which contain more fish than water, tales which sound incredible to those who have never visited Alaska, but which in many cases are strictly true.

The salmon have been traced as far north as Hotham Inlet, and one species is found well to the eastward of Point Barrow. It is quite probable that this species, the little humpback, extends its migration to the Mackenzie.

The rivers and lakes of Alaska contain five species of whitefish, the largest one (*Coregonus richardsoni*, Pl. VII, Fig. 1), sometimes reaching a weight of 30 pounds. For many years this was believed to be identical with the common whitefish of our Great Lakes fisheries, but it differs from this in many particulars. The species was known to the Russians as the "*muksun.*" In the report of the Commissioner of Agriculture for 1870, page 386, Dall refers to it as the "broad whitefish," which, he says, "is usually very fat and very good eatng. It abounds in both winter and summer, spawning in September in the small rivers falling into the Yukon." This is the species which Milner named *Coregonus kennicotti*, in honor of Robert Kennicott. Capt. E. P. Herendeen, of the Signal Service expedition to Point Barrow, found this whitefish in Meade River in October, 1882. This stream is a tributary of the Arctic Ocean to the eastward of Point Barrow. The southern limit of this species is not known, but it probably extends at least as far south as the Bristol Bay region. The great size and fine quality of its flesh make it one of the most important food-fishes of the Territory.

The round whitefish, shad-waiter, or chivey of New England (*Coregonus quadrilateralis*, Pl. VIII, Fig. 2), extends through the upper Great Lakes region, the Northwest Territory, and other parts of British Columbia, into Alaska. Specimens have been obtained as far north as the Kuwuk or Putnam River, a tributary of Hotham Inlet. This fish does not reach a large size, seldom exceeding 2 pounds in weight, but it is very abundant and palatable, and consequently is an important food resource.

A third species, called *Coregonus laurettæ* (Pl. VII, Fig. 2), abounds from the Bristol Bay region to Point Barrow. It is a little larger than the round whitefish, but seldom exceeds 3 pounds in weight. It resembles the so-called lake herring (*C. artedi*) of the Great Lakes, and is an excellent food species.

The fourth species is known as the humpback whitefish, and was named in honor of Mr. E. W. Nelson (*Coregonus nelsoni*, Pl. VIII, Fig. 1). It bears considerable resemblance to one of the Siberian species, from which, however, it can be readily distinguished. As food for man it has little value, but enormous quantities are consumed by the dogs. This species is found in all parts of the Territory from the peninsula of Alaska northward. Breeding males have a very large hump developed on the nape, which is compressed to a thin edge.

The fifth species of whitefish (*Coregonus pusillus*, Pl. VII, Fig. 3) is the smallest of all, and has the reputation of being more bony than any of the others. It is used chiefly by native traveling parties and as food for dogs. This fish seldom exceeds a foot in length and its average weight is less than 1 pound, but it extends over a large part of Alaska, and is represented by a vast number of individuals. As far as our information goes, it is found in all parts of the Territory except the southeastern portion.

The largest and handsomest fish of this category is the so-called Mackenzie River salmon or *inconnu* (Pl. VIII, Fig. 3), which is known to the Russian-speaking people as the *nelma*. This species is intermediate between the whitefish and the salmon. It has a strongly projecting lower jaw, on account of which the additional name of shovel-jawed whitefish has been applied to it. This beautiful species attains to a length of 5 feet, and individuals weighing 50 pounds are recorded. It occurs in the rivers during the greater part of the year, is in the finest condition in the early summer, and is "full of spawn from September to January, when it disappears." The species is known to occur from the Kuskoquim to the Kuwuk. The largest individuals are recorded from the Yukon. It is found also in the Mackenzie. A closely related species is found in the Volga and other rivers of Russia, and is attributed also to the Obi, Lena, and Colima, which flow into the Arctic Ocean.

The grayling (*Thymallus signifer*, Pl. VI, Fig. 3) is a very common fish in Alaska, especially in the northern portion of the Territory, and it is one of the most attractive of all the Alaskan fishes. At one time the grayling had the reputation of being the only fish in the fresh waters of Alaska that could be caught with hook and line. It is known also as the "blanket fish," and occurs southward at least to the Nushagak region, where McKay found it "very abundant in small rivers and lakes." He speaks of it as "a good food-fish, much sought after by the natives in the fall, along with the whitefish and the great smelt." The high and beautifully colored dorsal fin of this species, the rich purple luster of the sides, and the jet black spots not far behind the head, make it one of the most conspicuous and beautiful species of the fresh waters.

The red-spotted brook trout of California, also known as the dolly varden (*Salvelinus malma*, Pl. VI, Fig. 2), is one of the best known and most abundant fishes of Alaska. In the sea-run condition, when its sides are uniform silvery and do not show the red spots, it is called the salmon trout, and, preserved in brine, forms a staple article of commerce. In Alaska the species increases in size northward. Individuals measuring 30 inches in length and weighing 8 or 10 pounds are frequently obtained. Natives of northern Alaska make waterproof clothing from the skin of this trout. The dolly varden abounds in all parts of the Territory, even in the Aleutian Islands and in the extreme northern limits. It is known to occur also in the Mackenzie and in the tributaries of the Saskatchewan—this basin apparently representing its eastern limit. The dolly varden trout takes the artificial fly very freely. On one of the islands of the Shumagin group several hundred were so captured in one hour by a party from the United States steamer *Albatross* in 1889. Salmon eggs prove very effective also in taking this trout. The species is very destructive to the eggs of the various kinds of Pacific salmon. The young trout are destroyed in enormous numbers by gulls, terns, and other aquatic birds.

The lake trout (*Salvelinus namaycush*) or namaycush, tuladi, togue, lunge, etc., of the Great Lakes, New England, Labrador, Idaho, and British America (Pl. VI, Fig. 1), has been obtained in the Putnam or Kuwuk River, where it reaches a fine state of development. The southern limit of this species in Alaska is not known. This is the largest trout of North America and the most widely distributed. Its great size and the good quality of its flesh render it a very important species wherever it is known. This is one of the most variable of the North American trout in color, and much confusion has arisen from this circumstance. Individuals from the Kuwuk are similar in appearance to Labrador specimens, differing only in being slightly darker.

The rainbow trout of California (Pl. V, Figs. 2 and 3) appears to extend northward into southeastern Alaska, but is very little known in the Territory, and, consequently, is not of much importance there. One specimen of this trout was taken at Sitka by Capt. Beardslee in 1880, and is now preserved in the U. S. National Museum.

Gairdner's trout (Pl. V, Fig. 1), known also as the steelhead salmon, or "*soomgah*" of the Russians (*Salmo gairdneri*), reaches a very large size in Alaska, and extends northward at least to the Bristol Bay region. At Sitka this species is called "*Ah-shut*" by the Indians. We found gravid females at that place in June. This trout generally finishes its spawning before the arrival of the salmon, and is charged with the destruction of salmon eggs in large quantities. The species has not much importance commercially, although it reaches so large a size, attaining to the proportions of the Atlantic salmon, which it resembles in shape and color; but small quantities are dried by the natives and at the various fishing stations. This is the trout which is shipped from the Columbia River early in the spring to markets on the east coast, and sold in the fresh state under the trade name of "Kennebec salmon." Its distinction from the rainbow trout is difficult, and the two may prove to be identical. It will undoubtedly become an important species before many years. At the present time it is practically a waste product of the salmon fisheries of Alaska, and the same may be said of the dolly varden.

Clark's trout (Pl. IV, Figs. 2 and 3), recently styled the red-throat (*Salmo mykiss*), is very abundant in Alaska, extending northward at least to the Bristol Bay region. In the streams it can be readily taken with various baits, and greatly increases the pleasures of angling. As a food-fish its quality is excellent, and it reaches a weight of 20 pounds or more. The species is black-spotted, the spots being larger and less numerous in Alaskan individuals than in most of the varieties which range southward in the Rocky Mountain region. The crimson streak around the throat is a conspicuous and characteristic color mark in all the many forms of this well-known trout.

Before passing to a review of the Pacific salmons we must recall the fact that Alaska has a bountiful supply of small fishes closely related to the larger *Salmonidæ*. A true smelt (Pl. IX, Fig. 2) and two kinds of surf smelt (one of these on Pl. IX, Fig. 3) are among the common fishes, the first being a food-fish of considerable value. The capelin (Pl. IX, Fig. 1), abounds on all parts of the coast, and is one of the most important food species of the cod and salmon. The eulachon, or candle-fish, is extremely abundant in southern Alaska, and is considered one of the finest pan-fishes known. A kind of fat is expressed from it which the Indians use as a substitute for butter, and which some pharmacists employ in the place of cod-liver oil. The species is so full of oil that when dried it will burn with a bright flame.

These smaller representatives of the salmon family have at present little commercial value, but they will figure eventually and very prominently among the resources of Alaska. In addition to their value as food for man, they play a very important part in attracting the larger commercial fishes of the salmon family to certain localities.

It may be well to state that the herring of Alaska is one of the finest species of the genus *Clupea*, and is universally known as one of the fishes upon which the salmon subsist. The herring visits all parts of the coast of Alaska, running up into the bays in schools, sometimes covering an area of many square miles. It comes into the shallow waters of the bays to deposit its eggs, reaching Cook Inlet for this purpose early in July, so that its appearance in force coincides with the height of the salmon runs The capelin is also found early in the summer, and we know that salmon are very eager in their pursuit of this fish. The little sand launce, or lant, is also present in the bays in wriggling masses at the period when salmon abound.

The marine life of the Alaskan salmon is unknown from the time the young, in their newly-acquired silvery dress, leave the fresh-water nursery to become salt-water sailors, until they have ended their cruise, obtained their liberty, and come ashore, when, as in the case of so many other salt-water sailors, their serious trouble begins. Salmon remain in fresh water until the second or third spring of their existence, and not having a bountiful supply of food, they grow very slowly and seldom exceed 8 inches in length when they start seaward. In the ocean they feed on the capelin, the herring, and a small needle-shaped fish called the lant. They are reputed also to consume large quantities of pink-fleshed crustaceans, and to derive from them their attractive color. Opposed to this theory is the fact that many other sea fishes whose food consists almost entirely of such crustaceans are never pink-fleshed.

There is no such fishery at sea for any of the Pacific salmons as there is in the Baltic for the Atlantic salmon. After the great schools have broken up and the scattered fish come into the bays, some of the species can be caught on a herring-baited hook by trolling. The king and silver salmon are captured in this way.

As a rule the fish remain at sea until they are about ready to deposit their eggs, and then approach the coast in great masses. A few young males accompany the schools every year, and may or may not return to sea without entering the rivers. The adult fish come up from the sea at a certain time of the year, the king salmon arriving first in the month of May in southern Alaska and about the 6th of June in Norton Sound. The dog salmon and the red salmon appear in June, the humpbacks in July, and the silver salmon in August. The length of their stay at the river mouths before ascending and the rate of ascent to the spawning grounds depend upon the urgency of the breeding condition. In the long rivers the king salmon travels from 30 to 40 miles a day; this species and the red salmon are reported to be the greatest travelers. The silver and dog salmon, however, are recorded by Dr. Dall as traversing the Yukon at least 1,000 miles. As a rule, they frequent the smaller streams, and the little humpback runs into mere rivulets.

From the time the salmon enters fresh water it begins to deteriorate in flesh and undergoes remarkable changes in form and color. Arriving as a shapely fish, clad in shining silvery scales, and with its flesh pink or red, it plays around for a little while between salt water and fresh, and then begins its long fast and its wearisome journey. No food is taken, and there are shoals, rapids, and sometimes cataracts to surmount; but the salmon falters not, nor can it be prevented from accomplishing its mission by anything but death or an impassable barrier. Its body soon becomes thin and lacerated, and its fins are worn to shreds by contact with the sharp rocks. In the males a great hump is developed on the back behind the head, and the jaws are lengthened and distorted so that the mouth can not be closed. The wounded fish are soon attacked by the salmon fungus, and progress from bad to worse until they become unsightly. In the mean time the body colors will have varied from dark gray in the humpback, with the lower parts milky white, to a brilliant vermilion in the red salmon, contrasting beautifully with the rich olive green of its head. The excessive mortality of salmon during the ascent of the streams and on the breeding grounds has led to the belief that none of the spawning fish leave the fresh water alive. There is a substantial basis for this view in the long rivers, and it is doubtless true that a journey of 500 miles or more is followed by the death of all the salmon concerned in it.

The nest is a very simple affair, or it may be wanting. The humpback struggles and crowds up a few rods from the sea and deposits its eggs between crevices in the bowlders covering the bottom, or sometimes they are strewn in thin layers over a large area in shallow water without covering of any kind. The king salmon seeks the headwaters of streams, and excavates a nest in clear, shallow, gravelly rapids. The dog salmon spawns in small rivers and creeks.

The silver salmon does not usually ascend streams to a great distance, and I have seen it return to salt water alive, after spawning. The nest is made among gravel and stones, from which all dirt and slime have been removed. Both sexes take part in the building operations, and the male especially guards the nest. Turner states that the silver salmon use their snouts in collecting material for the nests, and he has seen them with the nose worn off completely.

The red salmon spawns around the shores of deep, cool lakes, and in their tributaries, preferring waters whose highest temperature rarely exceeds 55 degrees. The nest is a shallow, circular pile of stones, some of which are about as large as a man's hand and some of them smaller. The eggs are placed in crevices between the stones.

The enemies of the salmon are numerous. Small fish called sculpins, or miller's thumbs, swarm in the nests and eat large quantities of the eggs. Trout devour great numbers of eggs and young salmon. Gulls, terns, loons, and other birds gorge themselves with the tender fry. When the young approach the sea they must run a cruel gauntlet of flounders, sculpins, and trout; and in the ocean a larger and greedier horde confronts them. There the adults are attacked by sharks, seals, and sea lions. Before they have fairly entered the rivers huge nets are hauling them to the shore almost every minute of the day, during six days in a week. When they reach their spawning-grounds, bears are waiting to snatch them from the water and devour them alive. The salmon, it appears, would have been better off had it never been born in fresh-water, where its dangers are cumulative and deadly.

The King Salmon (*Oncorhynchus chouicha*). Plate II, Fig. 1.

The largest and finest of the Alaskan salmon is the king, or chowichee, known also as the takou, Columbia River, chinook, and quinnat. This valuable fish occurs in the large rivers as a rule, but it runs into some of the small streams also, notably the Karluk, and some of the rivers emptying into the eastern part of Cook Inlet. The Yukon and the Nushagak are the greatest king salmon rivers. The species is found less abundantly in the Ugashik, Kuskoquim, and Kvichuk. Its average weight is over 20 pounds, and individuals of 100 pounds or more are recorded. At St. Paul, Kadiak, in 1880, Mr. B. G. McIntyre stated he had weighed one which registered 87½ pounds without its viscera; he believed the entire fish would have weighed 100 pounds.

The flesh of the king salmon is paler in color than that of the red salmon, but superior to all others in flavor. The salted bellies are considered a great delicacy. The principal uses of this fish are as fresh fish and for canning purposes. In Alaska it has not yet acquired the importance belonging to it on the Columbia River, chiefly because of the distance from San Francisco to the Alaskan king salmon rivers and the difficulties of fishing in those waters.

This species is the first to arrive on the shores in the spring. It makes its appearance in southern Alaska in May, and Mr. E. W. Nelson found it in Norton Sound, the northern limit of its known migration, early in June. The time of its coming into Norton Sound corresponds with the breaking up and disappearance of the ice. Mr. Nelson observed that "the largest of these salmon run during the few days just preceding and following the breaking up of the ice, and thence on until the end of the season they decrease gradually in size and quality." In the Yukon the season lasts only about a month. Capt. L. P. Larsen states that the king salmon is the first to appear in the Nushagak; here the run is short, scarcely continuing into August. At the Karluk they arrive late in May. Very few were seined there during August. On the 4th of August, 1889, a fine male of about 35 pounds, with the spermaries little developed, was seined on the beach. In its stomach I found forty-five capelin. Mr. Charles Hirsch states that the species is only an occasional visitor at Karluk.

The king salmon continues to enter some of the rivers for the purpose of spawning until August. The height of the season, however, is reached by the middle of July in most localities. This fish travels up the rivers farther than any other species except the red salmon. In the Yukon it ascends far above Fort Yukon, more than 1,500 miles from the mouth of the river. Dr. George M. Dawson records its occurrence in the Lewes River as far as the lower end of Lake Marsh, where it was found in considerable numbers early in September. According to Indian authority it pushes on almost to the headwaters of the tributaries to the Lewes on the east side.

The king salmon does not ascend rivers rapidly unless the spawning period is close at hand. It generally plays around for a few days, or even a couple of weeks, near the river limit of tide-water. After entering the fresh water to begin its journey to the headwaters of the stream it moves rapidly until it finds suitable gravelly bottom in clear water. No food is taken in fresh water. When a barrier to its ascent is met I am told that the fish charges at it repeatedly and persistently without regard to the consequences to itself. The nest-building habits have been so often described that it is unnecessary to repeat them here. The spawning takes place, as before remarked, near the headwaters of streams in clear, shallow rapids. As far as we can learn, only those fish that ascend the streams short distances return to the ocean after spawning, and September is the month in which the spent fish go down to the sea. Mr. Turner mentions a female weighing 38 pounds, which had spawned and returned to the sea and was caught at Unalaska, September 25, 1878; it was in fine condition for eating.

There is no reason why the king salmon should not return down the Karluk, as the distance is very short and the fatigue of the journey upstream is very slight. There is ample testimony of a conclusive nature to the effect that after a king salmon ascends 500 miles from the sea it never returns to it alive.

Mr. Charles Hirsch says that the Karluk natives watch for the king salmon in May, and set up a great shout as soon as they discover it. Like the other species, it can be seen about 1½ miles off shore in great schools, but before coming nearer the schools break up. There is no salt-water fishery for this salmon in Alaska, except along the beaches.

No falling off has been observed in the supply of the king salmon; in fact the number used is very small in comparison with that of the red salmon.

The Dog Salmon (*Oncorhynchus keta*). Plate III, Fig. 3.

This is one of the least important of the Alaskan salmon to Americans, but one of the most valuable to the natives. Its flesh is comparatively pale, and it deteriorates so rapidly in fresh water as to prove very unattractive to white people. Mr. Daniel F. Bradford states that after remaining in fresh water twenty-four hours the fish turn black, become covered with slime, and are unfit for food. The jaws become enlarged and distorted, and the flesh unpalatable. In the fresh-run condition the flesh has a beautiful red color, resembling that of the red salmon, but not so brilliant. Early in July the red color of the skin is somewhat remarkable in being interrupted at intervals along the sides, causing a sort of resemblance to bands. The average weight is about 12 pounds, but some individuals reach 20 pounds.

This species is found chiefly in the small rivers and creeks, and is usually very abundant in all parts of the Territory as far north as Hotham Inlet, and probably Point Barrow. In the rivers of California and British Columbia it is said to appear seldom or never in the spring, but in Alaska it makes its appearance on the coast in great schools about the middle of June and continues abundant for nearly a month, after which it decreases rapidly in numbers, disappearing usually about the time of the forming of the ice.

In the small streams falling into Alitak Bay, with only a few exceptions, this fish and the little humpback are the principal salmon, and the natives dry them for winter use in large quantities. The Sturgeon River, according to Mr. Charles Hirsch, never contains any but dog salmon and humpbacks. In the Karluk River the dog salmon is only an occasional visitor. At St. Paul, Kadiak, Mr. Washburn says that the *Hyko* arrives about July 1, and there is only one annual run. On the 30th of August, at Karluk, a haul of a large seine yielded forty dog salmon and only one red salmon.

Early in July the fish-drying frames of the natives on the shores of Cook Inlet are red with the flesh of the drying dog salmon, or *Hyko*. The natives cut off the head, split the fish in halves, and remove the backbone, allowing the two halves to remain fastened at the tail. The sides are gashed at short intervals in order to facilitate the drying. The fur-traders lay in a large stock of this dried salmon, which is known to the trade as *ukali*.

The Silver Salmon (*Oncorhynchus kisutch*). Plate IV, Fig. 1.

The silver salmon is considered an excellent fish in the Puget Sound region, but is not so highly esteemed in the northern part of Alaska. It is used to some extent for canning, but is far less important for this purpose than the red salmon. It reaches a weight of about 30 pounds; the average weight in Alaska is less than 15 pounds. In Alaska, as in the Puget Sound region, it is a fall-running fish. It does not ascend the streams to any great distance, and I have seen spent fish of this species coming down alive in the fall to within easy reach of salt water. Whether the species actually leaves the fresh water after spawning is uncertain. There is a conflict of observation on this subject. Mr. J. W. Clark, agent of the Alaska Commercial Company at Nushagak, a very reliable and intelligent man, states that he has seen silver salmon come down the river alive in the spring. In some other Alaskan rivers, Capt. Lansburg, superintendent of the Thin Point cannery, has seen only black and lank-looking salmon of this species during the winter.

At Afognak the species arrived August 5, 1889, but there was no extensive run till about the end of the month. A small silver salmon was seen at Karluk August 4. The species was not abundant there, however, until early in September, when about 7,000 were caught at one haul of the seine. It was about this time that one of Capt. L. P. Larsen's men at Karluk hooked a very large silver salmon, probably weighing over 30 pounds. This species is only an occasional visitor at Karluk. When it runs there it generally begins about the last of August, according to Mr. Charles Hirsch. Mr. Washburn informed me that it arrives at St. Paul late in August or in September, and that there is only one annual run. A few fish of this species are found in the small river in Olga Bay, near the cannery of the Arctic Packing Company. It has been stated by Mr. Daniel F. Bradford that silver salmon do not furnish 10 per cent of the pack at the fisheries. In the river at Thin Point, a small and very shallow but constant stream, both silver and red salmon are found, the latter predominating. The season closes here early in September.

The silver salmon make their nests among the gravel and stones, from which they clean all dirt and slime. They use their snouts in collecting material for the nests, and Mr. L. M. Turner states that he has seen them with the snout worn off past the muzzle. After the spawning season, and during their stay in fresh water, they continue to be very much emaciated and in poor condition generally.

No decrease has been observed in the supply of this salmon as far as we are informed. Its late arrival in most localities limits the season during which it can be caught, and this serves as a sort of protection for the species.

The Humpback Salmon (*Oncorhynchus gorbuscha*). Plate III, Figs. 1 and 2.

This is the smallest, most abundant, and most widely distributed of the Alaskan salmon. Its average weight is about 5 pounds, and individuals weighing 10 pounds are very uncommon. It may be recognized readily by its excessively small scales, and, in the breeding season, by its greatly distorted jaws and enormous hump. It is found in all parts of the Territory. Its range is known to extend several hundred miles to the eastward of Point Barrow, and probably includes the Mackenzie. Speaking of its extraordinary abundance, Mr. Turner has aptly remarked that "they appear at the surface of the water like the pin-drops of an April shower."

Mr. Charles Hirsch has informed me that from about the 6th of July, 1890, there was in the Karluk River, continuing for five weeks, a glut of humpback salmon which kept all other salmon out of the river. It was impossible to pull a boat across the stream, owing to the great quantities of salmon. A haul was made with a 15 fathom seine at 6 a. m., and the men were dressing fish from that haul until 6 p. m. About 140 barrels were dressed. These were loaded in bulk into a small schooner, and then the men were occupied three hours in clearing the seine, in which the remaining salmon were about 4 feet deep. In the season of 1891 not more than 100 of these salmon were caught at Karluk up to the close of the fishing, October 5.

The humpback arrives at St. Paul, Kadiak, about the 10th of July, and there is only one run a year. From the statement of Mr. Hirsch, above referred to, it will be seen that it makes its appearance on the western side of the island at about the same time. Mr. Turner records the date of arrival at St. Michael as about the 25th of July and the period of running about five weeks. Mr. Nelson's earliest specimens were taken at St. Michael July 24. He says they are rather numerous until the end of July, with more or less common stragglers until late in the fall. The writer found humpbacks in good condition in Plover Bay, Siberia, about the middle of August.

The species continues to enter the rivers usually for a period of about five weeks, but is not regular in its appearance. The enormous run in the Karluk, mentioned above, was exceptional, for the fish seldom enters that river. In the Yukon, during some years, according to Mr. Nelson, only a few are taken, and at other times they are present in such excessive numbers in the lower part of the river that the fish-traps must be emptied several times a day.

This salmon is much addicted to jumping out of the water. In the vicinity of St. Paul, Kadiak, one of the commonest sights was this breaching of the humpback salmon. Fishermen at this village say that the sea-run humpback often contains a small fish, which, from their description, must be the capelin.

In the Karluk River, as already mentioned, the species continued to enter for five weeks, and then dead fish began to float down the stream, and this continued about a month. It does not go far from salt water and frequently enters streams which are too shallow to cover its fins. Its business in the fresh waters is simply to deposit its eggs, after which, apparently, it dies on the spawning-grounds or is carried to sea in a dying condition. Spawning takes place within a few rods of the sea. It is a common thing to see large areas of the bottom entirely covered with the eggs, either lying unprotected on the gravelly bottom or partly concealed in crevices between moderately large stones. In Afognak River the eggs were cast among stones about half as large as a man's fist.

There are no signs of diminution of the supply of this fish. A small number are salted annually, and the natives dry large quantities for winter use.

In the fresh-run condition this is one of the most palatable salmon in Alaska, and the time is not far distant when it will be a very important species for canning. The flesh is somewhat paler than that of the red salmon, yet it has a beautiful color. Properly introduced into the markets this would become a very valuable fish, and its wonderful abundance would establish a great industry.

The height of the spawning season in the Kadiak streams is evidently about the middle of August. In Alexander Creek, near the Larsen Cove cannery of the Arctic Packing Company, Messrs. Robert Lewis and Livingston Stone found the humpbacks spawning in vast numbers August 15. Mr. Lewis took some of the eggs and fertilized them with the milt of the males. The eggs are larger than those of the red salmon, but smaller than king salmon eggs and not so bright red. On the 22d of August, 1889, this fish was observed in the small streams at the head of the west arm of Uyak Bay trying to run up the rapids in order to spawn. The current in some places was so swift as to wash the fish away. Eggs were very plentiful between the crevices of the stones. On the 24th of August Alexander Creek was full of humpbacks in all stages of emaciation and decay. In Alitak Bay, September 9, the fish were nearly all dead in the creeks, and Snug Harbor contained many dying humpback salmon floating seaward tail first. Messrs. Booth and Stone found Afognak River well filled with spawning humpbacks August 30. The two tributaries of Afognak River also contained them in great numbers. Mr. Booth found the fish most abundant in the neighborhood of holes excavated in the egg-sized gravel of the bottom, intermingled with stones of 3 or 4 pounds in weight.

After the great run in the Karluk, already referred to, the fish came down dead or in a dying condition for a whole month and the beaches were strewn with dead salmon. The distortion of the humpback during the breeding season is remarkable and the injury to its fins, and other exposed portions of the body, is excessive. The last stages of this species are repulsive to look upon, but before the extensive emaciation and sloughing away of the skin has taken place the colors of the breeding fish are rather pleasing, the lower parts becoming milky white, contrasting beautifully with the darker color of the sides and back. This white color sometimes extends upward toward the middle line with interruptions.

The Red Salmon (*Oncorhynchus nerka*). Plate II, Figs. 2 and 3.

This is the blueback of the lower Columbia River, the *Sawqui* or *Sukkegh* of the Frazer River, and the *Krasnaya Ryba* (or redfish) of the Russians. It does not seem to exist south of the Columbia River. Northward it is found as far as the Yukon, and it occurs also in Japan and Kamschatka.

Although next to the smallest of the Pacific salmons this is now the most important species for canning and salting, and its flesh is so red as to win for it a reputation not warranted by its edible qualities. It approaches the shores early in the spring and enters only snow-fed streams. The red salmon is not caught, like the king and silver salmon, by trolling in the bays. When it comes into the mouths of the streams, to ascend for the purpose of spawning, the fishing begins.

The size of the red salmon varies with the locality and season. Some runs contain much larger fish than others. At Karluk the fish will average nearly 4 pounds apiece without the head, fins, tail, and viscera. The whole fish will weigh 7 or 8 pounds. In 1889 it was estimated that 13 fish would make a case (48 pounds) of canned salmon; in 1891 the number to the case was stated to have been 15. Individuals of 15 pounds are occasionally seen, but they are uncommon.

Like the king salmon, the red salmon [illegible] on to their sources; but it is chiefly a lake species which [illegible] headwaters of the principal rivers to their small tributaries.

Red salmon arrive at St. Paul, Kadiak, according to Mr. W[illegible] Alaska Commercial Company, in June, and [illegible] man also states that there is a little run of small red salmon in [illegible] as early as April 1, but the principal run comes in June [illegible] miles distant from the Little Afognak the first run [illegible] At Karluk, in 1889, and around Kadiak generally, the [illegible] catch up to the end of July was small everywhere [illegible] as the time when the natives of Attu Island [illegible] to obstruct the passage of the red salmon in their [illegible] does not appear to be common on the coast of Norton Sound [illegible] but is more abundant in the lower Yukon [illegible] of August and lasting sometimes only two or three days [illegible]

At the end of August, 1889, the red salmon [illegible] but had greatly diminished in numbers and had [illegible] for canning. In 1890 the run continued at [illegible] the catch was obtained in [illegible] usually lasts only [illegible] the middle of June, and [illegible]

[illegible]

resting, during the ascent of the Karluk. Numerous beds of eel-grass and other aquatic plants furnish attractive hiding-places in which the fish sometimes linger.

The red salmon ascends to the lake or lakes which the river drains, and it is said that this species will not enter a river which does not arise from a lake. The distance traveled in the Karluk is less than 20 miles, and the principal lake is 8 miles long. Red salmon spawn in this lake and in the short and rapid rivers connecting each of its arms with smaller tributary lakes. They ascend long rivers, like the Columbia, more than 1,000 miles, to reach the spawning lakes.

This salmon begins spawning soon after its arrival on the coast, and this varies with the locality. The season usually begins in June, and fish which have not yet spawned continue to arrive as late as the beginning of September. Spawning takes place in August, as the writer knows from personal observation. Dead fish and others which have spawned and are already dying are very abundant about the middle of this month. In Karluk Lake, near the sources of the river, ripe red salmon were speared by the natives August 17, 1889. On the 18th of the same month large numbers of dead salmon of this species, and plenty of both sexes which were spent and nearly dead, were found in the rivers connecting Karluk Lake with its tributary lakes. In all of the little streams falling into Karluk Lake, in which red salmon were found, dead fish were moderately common; and there was an abundance of young salmon about 1½ inches long, which must have been hatched from eggs deposited during the preceding fall. Mr. Charles Hirsch stated that "in March or April the Karluk River is solid full for a whole month of salmon fry going down to sea."

I have seen salmon nests at the head of Karluk Lake in shallow water near shore between the mouths of two streams. The nest is a hollow circular pile of stones, and the eggs are placed in the crevices between the stones. In the river connecting the east arm of Karluk Lake with its tributary, additional nests of salmon were observed. In some cases streams fall down into Karluk Lake over bluffs which are too steep for the salmon to ascend, and the fish were spawning at the mouths of such streams.

Extensive changes take place in the color of the red salmon as the spawning season approaches. After a period in fresh water the skin becomes dark and the beautiful red color of the flesh gives place to a paler tint. In this condition the fish has no commercial value. According to Mr. Bradford, the arrival of dark-red salmon in quantities later in the season at Karluk indicates a decrease in the run. In the height of the spawning season the sides are suffused with a brilliant vermilion, and the head is a rich olive-green, contrasting sharply with the color of the body. The male develops a hump nearly as large as that of the humpback, and its jaws are greatly enlarged.

The eggs and young of the red salmon have many enemies, and the percentage of fish naturally developed from eggs must be exceedingly small. Every salmon nest has its greedy horde of little fresh-water sculpins (otherwise known as miller's thumbs), blobs, and bullheads (*Uranidea* spp.), always in readiness to consume the fresh eggs. The shoal waters around the shores of Karluk Lake, and the shallow streams into which the red salmon finds its way for reproduction, contain myriads of these destructive little sculpins. Another source of destruction to the eggs is found in the dolly varden trout (*Salvelinus malma*), which is only too common on the spawning-grounds of the salmon and consumes large quantities of eggs. The waters referred to contain, also, a great many sticklebacks (*Gasterosteus* sp.), some of them of very large size, which probably destroy eggs.

Chief among the destroyers of the young fish are terns, gulls, ducks, and loons, which are very common in that region. I have shot terns and gulls near the south end of Karluk Lake, and upon holding them up by the legs small salmon dropped out of their mouths. Towards the end of August, 1889, the shallow parts of Karluk River were visited by hundreds of gulls, chiefly young of *Larus glaucescens* and *L. brachyrhynchus*, which were feeding upon young salmon. Bears consume large quantities of the breeding fish. They may be seen standing at the edge of the stream, where the water is shallow, and occasionally striking salmon with their claws and throwing them on the shore, where they are eaten alive. I have seen red salmon partly eaten, but still alive, lying on the shore after the retreat of the bears, which were disturbed while feeding. Other enemies of the salmon attack it in the sea; among them are the salmon shark (*Lamna cornubica*), porpoises, and sea lions. All species of salmon are more or less covered with parasitic *copepods*. The estuary of Afognak River is generally left bare at low tide, and great numbers of salmon are thus stranded, many of which die before the next tide rescues them.

Red salmon are seen in salt water off the mouths of the rivers in large schools in the spring. No attempt has been made to take them until they come to the shore.

The catch of red salmon has been increasing, owing to the greater number of persons engaged in the fishery and the superior effectiveness of the implements used in its capture. The size of seines has been greatly enlarged, and the number of boats and seines largely augmented. There was, early in the season of 1889 and in previous seasons, injudicious obstruction of the ascent of spawning fish in the Karluk River. At one time an impassable weir, similar to the *zapor* of the Russians, was placed in this river. I have also seen the remains of pound nets made of wire netting, which interfered so seriously with the ascent of the fish that they were dismantled by unknown parties and were not reëstablished.

The Steelhead (*Salmo gairdneri*). Plate v, Fig. 1.

This large black-spotted trout is known also as hardhead and Gairdner's trout. The Russian name is *Soomga.* In some of our eastern markets it is sold as "Kennebec salmon" before the Atlantic salmon has come in from the sea. In the Rogue River, Oregon, the fishermen call it Rogue River trout.

It sometimes reaches a weight of 30 pounds, and individuals of that size bear a close resemblance to *S. salar.* It is found from Monterey, Cal., to Bristol Bay, Alaska, and is very abundant in some parts of the Gulf of Alaska. This trout has been considered a winter spawner, but females full of ripe eggs were seen by me near Sitka, June 10, 1880. Spent fish of this species are frequently taken with the spring run of the king salmon, so that in all probability the usual spawning time is late in the winter or very early spring.

This species, according to Mr. Charles Hirsch, arrives at Karluk in August in small numbers. I have seen a moderately large number of steelheads at Karluk on September 4, but their abundance was nothing in comparison with that of other species. It is seldom used at Karluk. A few small individuals are dried there by the natives.

The spawning habits of the steelhead are scarcely known. Mr. B. F. Dowell has recorded its arrival in May in Applegate Creek, Oregon, for the purpose of spawning. At the falls in the Willamette River, at Oregon City, Mr. Waldo F. Hubbard, of the U. S. Fish Commission, reported a few ripe females about the middle of May, 1892, but during the remarkably high water the fish passed over the obstructions and no eggs were secured. At Sitka I was told that it spawns in lakes not far from the sea, and immediately after spawning goes into the salt water.

In the opinion of Mr. Dowell the steelhead is "delicious in flavor."

The Red-throated Trout (*Salmo mykiss*). Plate IV, Figs. 2 and 3.

Clark's trout has recently been called the red-throated trout on account of the characteristic crimson streak around the throat. It is a large and extremely variable species, and its distribution is nearly or quite as extensive as that of the lake trout. One of its varieties is found in streams of the Sierra Madre, Mexico, at an elevation between 8,000 and 9,000 feet, in the southern part of Chihuahua, near the boundaries of Durango and Cinaloa. In Alaska it has been traced as far north as the Kuskoquim River, and doubtless extends still farther.

As a food-fish the red-throated trout is excellent and the species grows to a large size, individuals weighing 20 pounds being recorded. Although not now an important commercial fish in the Territory, it furnishes food for the natives and is taken in large numbers by anglers.

In the Rocky Mountain region it is represented by numerous varieties and is well known to fishermen and tourists. These are generally known as Rocky Mountain trout and may be readily distinguished by their black spots and the crimson dash on the throat. In the mountain lakes and streams of Colorado the trout come down to a point where the summer temperature reaches 60° to 65°. In the basin of the Colorado they are associated with small dace-like minnows, upon which they feed. They prefer clear streams with gravel bottoms. The species is not migratory.

In the Yellowstone National Park this trout occurs in both the Atlantic and Pacific watersheds, having traversed the waterway over Two-Ocean Pass.

The typical red-throated trout of Alaska differs materially in color from its Rocky Mountain representatives, having comparatively few large, roundish, black spots on the body, chiefly above the lateral line and evenly distributed along the surface; the head has a few black spots; the dorsal and caudal have a moderate number of black blotches which are usually oblong in shape.

Parasitism in the Rocky Mountain trout has been discussed by Dr. Yarrow in papers referred to below, and more recently by Dr. Jordan and Prof. Linton in the ninth volume of the U. S. Fish Commission Bulletin.

Gordon Land, fish commissioner of Colorado, has obtained eggs from this species on June 21 and they were hatched in 25 days in water varying in temperature from 52° Fahr. at night to 62° at midday; the eye-spots were plainly visible in 17 days from the time of taking the eggs. Mr. Land states that this trout is "easily taught to feed and will readily take food from the bottom as well as in transit."

An excellent account of the life history of the red-throated trout was published by Dr. H. C. Yarrow in the Report of the U. S. Fish Commission, Part II, 1874, in advance of its appearance in the Zoölogy of the Wheeler Survey Report in 1875. Under the name *Salmo virginalis* he treats particularly of the spawning, feeding, and movements of the species. From inquiry and personal observation he fixed the maximum length of the fish at 3 feet and the weight at 15½ pounds; but the average length is about 14 inches and the weight 1¼ pounds. The following extracts have been rearranged from Dr. Yarrow's description:

> In shape there is very little difference between the male and female, though near the breeding season the female is the larger and more brilliant in color. This increased brilliancy of color affects both sexes, but is noticeable in a more marked degree in the female. About breeding time the eyes are brighter, scales more brilliant, and the superficial blood vessels more fully engorged than ordinarily; the movements are more rapid, a celerity being displayed quite at variance with its usual somewhat sluggish habits. As far as could be ascertained, the spawn has not been observed to run from this fish when captured, either by the line or net, for the reason, most likely, that the gravid female is seldom taken just prior to or during the time of spawning. It first enters the mouths of mountain streams and rivers to spawn about the middle of March, remaining until the middle of May, by which time the majority have fulfilled their reproductive functions. In coming on to the breeding-grounds all sizes are found together, young and old, little and big. During the spawning season no very observable changes take place in the trout, except those mentioned above, and also that the under part of the cheek of the female becomes very bright. As a rule, it may be stated that in general appearance the male is much less bright than the female at this season, and smaller.
>
> Before spawning, the nests are made in the sand or gravel by a rotary motion of the tail of the male. The eggs are exuded by the female into this cavity, which is sedulously guarded by the male until the process is completed, when the latter deposits the milt which is to impregnate the eggs. No further care is taken by either after the deposition of the impregnating substance. Most of the spawning is done in the rivers, but the process takes place in the lakes also to some extent. It is not known at what age this fish begins to breed nor what period of time the process continues. The act of spawning exerts an injurious effect on the flesh of the fish, rendering it poor and insipid. In addition, many of the fish seeking the upper parts of the rivers to fulfill their reproductive duties do not survive the severe bruises and other injuries they meet with in their journey past the rocks and through the rapid currents of the mountain streams. The water in the locality in which the trout spawns has never been noticed to be whitened by the milt, but it does present a translucent pinkish appearance after the event.
>
> The temperature of water most favorable for hatching appears to be the coldest obtainable, the eggs in many cases being laid directly on the bottom of ice-cold mountain springs. The color of the spawn is whitish pink, each egg just previous to spawning being the size of No. 4 shot. In July the eggs are not larger than No. 12 or dust shot. The eggs when spawned always sink to the bottom, where they remain unless eaten or carried away by the swift current. The eggs are hatched in March, April, and May, but the number of days required by the process is not known. The spawn and young fish suffer greatly from the attacks of other fish, aquatic reptiles, and even from the large fish of their own species, these seeming to have no affection for their young. Mr. Peter Madsen states it as his opinion that the female in spawning ejects only a portion of her eggs, as he has found, on dissecting the trout after the spawning season, eggs of various sizes, some very small and others full grown.
>
> After spawning the trout invariably swim in schools from one part of the lake to the other in search of food, a solitary fish at such time being seldom seen. In traveling the trout is nearly always accompanied by its friendly companions, the mullet, sucker, etc., which share with it the danger of attack by man and birds. It is rather a singular fact that the very young trout is seldom seen or taken either by hook or net, and I am unable to account for the same unless it is that it resorts to unknown localities until a larger growth is obtained. Its food, so far as known, consists principally of small insects.
>
> The trout is very voracious, devouring other fish smaller than itself, particularly a species locally known as "silversides," or "leather-sided minnows" (*Clinostomus tænia*, Cope), of from 2 to 6 inches in length; on dissection, I found the stomach of the trout crammed with these little fish. Grasshoppers, too, are a source of diet to the trout, with flies and other insects, while they do not disdain even snakes and frogs of tolerably large size. The favorite localities for feeding in the summer are close to the mouths of rivers, the water of which from the mountains is ice cold, from 10 to 12 feet deep, and the current very swift.
>
> This fish winters in the deepest waters of the lakes, as most of the mountain streams to which it resorts in spring and summer are shallow and very cold. In summer it swims low in the water—it is thought, to avoid the extreme heat of the sun. The male and female, large and small, run indiscrimi-

nately together, the presence of this fish in any particular locality being indicated by the presence of flocks of birds hovering over the water.

Large captures are easily made with a hook, and I have taken 30 to 40 pounds weight in a single hour's fishing. The hooks used are large steel ones, with a snood or snell of piano wire, which is strong and flexible. The best bait is minnow and grasshopper, although this trout will bite at almost anything. In Panquitch Lake a fish's eye is considered a very tempting bait.—(Dr. H. C. Yarrow, Report Wheeler Survey, vol. v, Zoölogy, pp. 686–691.)

The Rainbow Trout (*Salmo irideus*). Plate v, Figs. 2 and 3.

The rainbow trout is not known to extend far into Alaska, but specimens have been obtained at Sitka by Capt. L. A. Beardslee, U. S. N. It is sometimes found in salt water, but spends most of its life in the streams. It is a valuable food-fish and grows to a large size, reaching 2 feet in length and about 8 pounds in weight.

At the Baird station of the U. S. Fish Commission spawning takes place in the small creeks tributary to the McCloud River, from January to May. The eggs are about one-fifth of an inch in diameter and vary in color from light straw to deep salmon-red. A 2-pound trout yields about 800 eggs. In water at 54° F. the eye-spots show in 12 days and the period of incubation lasts 26 days. The outline of the embryo can be seen through the shell four or five days before the eye-spots appear.

The rainbow trout derives its name from the broad red or crimson band which extends along the side and on the head; this contrasting with the rich silvery gray of the body and the iridescence of the sides gives the fish a beautiful appearance. In the spawning season the color of the body becomes much darker, the flesh paler, and the red stripe turns to crimson.

This species feeds chiefly on salmon eggs during the season and upon dead salmon. It is very fond, also, of the larvæ of the caddis fly. Mr. Loren Green believed that these trout stir up the bottom of the river with their tails when searching for food. According to Mr. Stone they have the peculiarity of swimming partly on one side when in search of food, with one eye inclined downward, so that they see what is on the bottom. In very hot weather they feed chiefly at night.

The fishing lasts from the middle of May to the last of November, June and July being the best months.

A disease has sometimes appeared among the rainbows, which has caused great mortality. Specimens of the diseased fish were examined by Prof. S. A. Forbes, who attributed the deaths to encysted parasites located principally in the kidneys, but also affecting the liver and spleen.

The Lake Trout (*Salvelinus namaycush*). Plate vi, Fig. 1.

The lake trout is the largest trout of the world and one of the largest, if not the largest, of the salmon family. It is indigenous to North America, occupying the northern portion of the continent, extending south to Silver Lake in Pennsylvania and Henry Lake in Idaho, and most highly developed and most abundant in the Great Lakes region, and extending northward to the Arctic Ocean on both sides of North America. In Alaska this trout is very abundant in the rivers and lakes of the northern part of the Territory. It has been found as far north as the Putnam or Kuwuk River, which falls into Hotham Inlet, and extends southward to the peninsula of Alaska. In color, the Kuwuk specimens resemble examples of the same species from Labrador, differing only in being slightly darker.

The color variations in this trout are remarkable; some examples are nearly black, others are brown with vermilion spots, still others are gray, with chain-like markings. In the Great Lakes the usual color is brownish gray, profusely dappled with whitish blotches. On account of its wide range, it naturally runs into many varieties of form and color, and adult individuals differ greatly in size in different localities. It is said that individuals weighing 120 pounds have been taken, but the average weight in the Great Lakes will probably not exceed 15 pounds, and an example weighing 80 pounds is regarded as the largest one ever taken in Lake Superior. The extreme weight above mentioned is given on the authority of Dr. Richardson, whose observations were made in Arctic North America. The Alaskan examples which I have seen were comparatively small, but Mr. Townsend and others who obtained these specimens state that the species grows to a large size in that Territory.

The lake trout is a voracious and predatory species. It associates with the white fish and lake herring, which constitute the principal part of its food. It devours other species of fish of suitable size, including the burbot or lake lawyer. Among the singular articles which have been found in the stomach of this trout are "an open jackknife (7 inches long, which had been lost by a fisherman a year before at a locality 30 miles distant), tin cans, raw potatoes, chicken and ham bones, salt pork, corn cobs, spoons, silver dollars, a watch and chain, and in one instance a piece of tar rope 2 feet long. In the spring wild pigeons are often found in their stomachs. It is thought that these birds frequently become bewildered in their flight over the lakes, and become the prey of the trout."

The lake trout appears to spawn only in the lakes, and not in rivers tributary to them. In lakes Michigan and Superior spawning takes place late in October, on rocky shoals and reefs, in water 70 to 90 feet deep. The eggs are said to be deposited in clefts in the rocks, into which they settle and remain until hatched. The young make their appearance in January or early in the spring, in water of a temperature of 47° Fahr. The hatching has been known to take place about the end of January. The late James W. Milner found some hatching-grounds at the head of Lake Huron, in depths of from 7 to 90 feet on rock bottoms. In a female weighing 24 pounds he counted 14,943 eggs.

In Lake Michigan Mr. Milner found that the lake trout, except in the spawning season, remains in the deepest part of the lake, and in their fall migrations they do not ascend the rivers nor are they found in outlets of the lakes. In northern Lake Michigan the fish are caught through the ice in winter in depths of more than 180 feet. The Indians of Sault Ste. Marie spear the lake trout through the ice, first decoying them within reach by means of a decoy of wood or lead roughly shaped like a fish.

In Alaska the lake trout becomes very plump, and on account of its great size and the good quality of its flesh it is a very important source of food for the natives. It has not at present any importance in the commercial fisheries, but must become a valuable market species in the future.

The Dolly Varden Trout (*Salvelinus malma*). Plate VI, Fig. 2.

This handsome species bears a very close resemblance to the sea trout of Labrador. It is known to commerce under the name of salmon trout. The Russian name of the species is *goletz*, and in Kamchatka it is the *malma*. In western Montana it is known as salmon trout and bull trout, the latter name being current also in California.

The name dolly varden was in use for it at Soda Springs, California, at least as early as 1872. The McCloud River Indians call it the *Wye-dar-deek-it.* In the McCloud its weight varies from 2 to 15 pounds. According to Mr. J. B. Campbell—

> It frequents the river from the junction (with the Pitt) to the spring, there being none above the spring and few near the river mouth. If one takes hold of the dolly varden it slips away nearly like an eel. The species is very destructive to other trout, or any kind of fish. It spawns in September and November. The eggs are about one-half the size of those of the common (rainbow) trout. The fish are very difficult to obtain. They will live in a small place where the common trout would not. I have kept them in a pond about 6 feet square for a month, where the rainbows would kill themselves in a short time. They appear to be more hardy.

The average weight of this trout in the sea fishery at Kadiak is about 2½ pounds. It reaches a length of 30 inches, and individuals weighing 8 pounds are often taken. It increases in size to the northward.

The dolly varden is a migratory species and passes much of its time in the sea near the river mouths; it enters the rivers late in the fall and descends in the spring. Mr. Washburn says that it arrives at St. Paul in April. It remains in the bay near St. Paul throughout the summer. Mr. Charles Hirsch states that it reaches Karluk in the latter part of May and runs through the whole season. Dolly vardens of a pound or more can be found in the streams at any time during the summer. Mr. E. W. Nelson found them at Unalaska early in June, and in the Yukon in the same month, but he says they are most numerous in the fall just before and after the streams freeze over. They enter the rivers and go up to their headwaters for the purpose of spawning. The spawning season is in winter and may begin very early in this part of the year. A female, opened on the beach at Karluk August 2, 1889, contained eggs which seemed to be nearly ripe.

Individuals taken at sea sometimes have capelin in their stomachs. In Karluk River, near its mouth, I have seen them feeding on eggs of the red salmon, which had been thrown into the water from the fish-cleaning houses. On the 5th of August I found a female dolly varden with very small ovaries; this example was long and slender. On August 16 a spent or sterile *malma* was found above the rapids in a little stream tributary to Karluk River. At the head of Karluk Lake, August 19, was discovered a very much emaciated trout of this species, which was struggling in the water and nearly dead. The inside of its mouth was full of large lernæan parasites.

The dolly varden spends the entire summer in salt water near the mouths of the rivers after it has reached a certain age; younger individuals remain in the rivers and lakes. Many thousands of these trout are caught in the seines hauled for salmon, and fisheries exist for this species alone in various localities. It is put up in pickle and sold in San Francisco. The demand there, however, is limited.

No serious diminution of the supply of this trout has been observed. There is great destruction of the fish, however, at Karluk in the seining for red salmon, where thousands of dolly vardens are taken and left lying unused on the beach. Something should be done to prevent this waste of good fish.

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BY TARLETON H. BEAN, M. D.,
Ichthyologist, U. S. Fish Commission.

In the compilation of the following list of papers free use has been made of the "Bibliography of the Fishes of the Pacific Coast of the United States to the end of the year 1879," by Theodore Gill. The "Partial List of Charts, Maps, and Publications relating to Alaska and the Adjacent Region from Puget Sound and Hakodadi to the Arctic Ocean, between the Rocky and the Stanovoi Mountains," by W. H. Dall and Marcus Baker, to which reference is made below, will furnish many additional titles.

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[*Salmo scouleri*, pp. 158, 223; *Salmo quinnat*, 219; *Salmo Gairdneri*, 221; *Salmo paucidens*, 222; *Salmo tsuppitch*, 224; *Salmo Clarkii*, 225, 307; *Salmo* (*Mallotus*) *pacificus*, 236.]

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[The list of fishes was evidently prepared by Dr. J. G. Cooper, although only general acknowledgment for assistance was rendered in the preface. It was acknowledged by Dr. Cooper, as author, in the communication to the California Academy of Sciences, indicated above. Inasmuch as this was intended to be a complete enumeration of the fishes of California, the names are reproduced here.]

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[Refers inter alias to capture and curing of [illegible]

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"VICTORIA, June 26. A salmon that [illegible]
Skeena River fishery by Mr. [illegible]

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mon, 280-286, 290-292; statistics 296, 301.)

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1883—*Ibid*, Suppl. No. 2, pp. 190–207. (Salmon, 190–192; statistics, 200–207.)

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[The Alaskan fishes, *Salmonidæ*, pp. 393–397, 415–419.]

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[A work which cost a prodigious amount of labor, but its value is greatly impaired by the want of a table of contents, index, chapter headings, and other aids usually provided for readers. In the measurement tables the species are not even grouped according to their affinities.]

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[Fishes, in notes by Charles H. Townsend, p. 95. Two poorly colored plates.]

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[Salmonidæ, pp. 313-320.]

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1889—Report of the cruise of the Revenue Marine steamer *Corwin* in the Arctic Ocean in the year 1884. By Capt. M. A. Healy, U. S. R. M., commander. Washington: Government Printing Office, 1889.

[Fish of the Kowak River, page 106.]

1889—Fur Seal and other Fisheries of Alaska. Report No. 3883, House of Representatives, Fiftieth Congress, second session (to accompany bill H. R. 12432).

[App. B, pp. XXXIV—XLIII, relate to Salmon and other fisheries. Salmon, pages XXXIV, XLII, and XLIII.]

1889—Annual Report on the Fisheries of British Columbia for the year 1889, by Inspector Thomas Mowat. In Annual Rep. Dept. Fish., Canada, 1889, pp. 247-254.

[Statistics of British Columbia Salmon Pack for fourteen years, on page 249.]

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Fisheries, in Report of Governor of Alaska, Lyman E. Knapp, pp. 234-236. Salmon, pp. 234, 235.

Fisheries, in Report of the Governor of Washington Territory, Miles C. Moore, pp. 545-548. Salmon, 545, 546.

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1890—Annual Report on the Fisheries of British Columbia for the year 1890, by Inspector Thomas Mowat, Suppl. No. 1 to the Annual Report of the Department of Fisheries, Canada, 1890, pp. 173-191.

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1890—Report on the Salmon and Salmon Rivers of Alaska, with Notes on the Conditions, Methods, and Needs of the Salmon Fisheries. By Tarleton H. Bean, Ichthyologist U. S. Fish Commission. Washington: Government Printing Office, 1890. Mis. Doc. No. 211, Fifty-first Congress, first session, pages 50, pls. 1-43.

[Reprinted in Bull. U. S. F. C., IX, 1889, pp. 165-208, pls. XLV-LXXXVII.]

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[Many references to salmon and the salmon industry, the more important being on pages 7, 9, 24, 158, 166, 176, 179, 180, 186, 187, 189, 190, 191, 192, 194, 197, 201-228, 235, 254-260. Plates XXI, XXII, XXIII, XXXIII, XXXIV, XXXV, XXXVI, XXXVII, XXXVIII, XXXIX, XL, XLIV, XLV.]

1891—Annual Report of the Department of Fisheries, Dominion of Canada, for the year 1890. Printed by order of Parliament. Ottawa: Printed by Brown Chamberlin, Printer to the Queen's Most Excellent Majesty, 1891.

Appendix No. 4. Special Report by Mr. S. Wilmot on the Salmon Fishery and Fishery Regulations of Fraser River, B. C. 1. The Canning Industry; 2. The Fishery Regulations; 3. Supplementary Pages, 63-77, four colored plates.

1892—Bulletin No. 4. Salmon and Trout of the Pacific Coast. By Dr. David Starr Jordan, president of the Leland Stanford Junior University. Sacramento: State Office, A. J. Johnstone, Superintendent State Printing, 1892.

Salmon and Trout of the Pacific Coast. (Pages 5-19.)

2.—DESCRIPTION OF A NEW SUCKER, PANTOSTEUS JORDANI, FROM THE UPPER MISSOURI BASIN.

BY BARTON W. EVERMANN, PH. D.,
Assistant, U. S. Fish Commission.

In the following paper is given a description of a new species of sucker, *Pantosteus jordani*, together with a discussion of the distribution of the various species of the genus *Pantosteus*, it being thought advisable to publish this in advance of the completion of a report upon investigations in the Black Hills region upon which I am now engaged, and of which this is to be regarded as forming a part.

PANTOSTEUS JORDANI sp. nov.

Pantosteus virescens, Jordan, Bull. 4, vol. IV, U. S. Nat. Mus., 1878, 780 (Sweet Grass Hills, Montana).
Catostomus discobolus, Evermann, Bull. U. S. Fish Comm. 1891, pl. XVIII, fig. 1, 41 (Red Rock River, Red Rock, Mont., and Beaverhead River, Dillon, Mont.).

Head, 4½ to 5½; depth, 4½ to 5; eye, 4½ to 5; snout, 2 to 2¼; interorbital width, 2¼; D. I, 10; A. I, 7; scales, about 16–96–14, 48 before the dorsal.

Body rather stout, subterete, back gently and regularly arched from snout to origin of dorsal, thence nearly straight to base of caudal; head small, short, and conic, interorbital space broad and but little convex; snout long, about half length of head; mouth large, broad; lower lip broad, very little incised, covered with tubercles of moderate size; upper lip also broad, extending well down on sides of mouth, tubercles in about 3 or 4 rows; cartilaginous sheath of lower lip well developed; caudal peduncle stout, not much compressed; scales small and much crowded anteriorly, lateral line straight and near axis of body; dorsal small, its height 1⅓ in head and a little greater than base of fin, its origin considerably nearer snout than base of caudal; pectorals long, about equal to length of head, reaching more than half way to the ventrals; ventrals short, not reaching vent; anal about ⅕ longer than pectorals, reaching base of caudal; fontanelle reduced to a very narrow slit, practically obliterated in the older individuals; peritoneum very black; air-bladder small, the posterior part long and very slender.

Color, dark-greenish above, scales covered very closely down to the paired fins with innumerable fine dark or greenish specks, most numerous on back; under parts pale; in life, or immediately upon putting in alcohol, some specimens were observed to have a broad orange band along the side, this probably being a marking present during the breeding season. Young specimens 2 to 3 inches long are frequently mottled very much like the young of *Catostomus teres* and *C. nigricans*.

This interesting species is based upon the following material:

U. S. Nat. Mus. No.	No. of specimens.	Locality.	Date.	Collector.
43963	13	Red Rock River, Red Rock, Montana	July 27, 1891	B. Clapham.
43964	13	Beaverhead River, Dillon, Montana	July 27, 1891	Evermann & Jenkins.
	185	Whitewood Creek, Deadwood, South Dakota	Oct. 6, 1892	B. W. Evermann.
	45	Spearfish Creek, Spearfish, South Dakota	Oct. 7, 1892	Do.
	3	Chicken Creek, near Spearfish, South Dakota	Oct. 8, 1892	Do.
	5	Crow Creek, Gammon's Ranch, near Spearfish, South Dakota.	Oct. 8, 1892	Do.
	3	Belle Fourche River, Belle Fourche, South Dakota	Oct. 11, 1892	Do.
	13	Rapid Creek, Rapid, South Dakota	Oct. 15, 1892	Do.
	2	Hat Creek, Ardmore, South Dakota	Oct. 21, 1892	Do.

In the report upon the explorations in Montana and Wyoming by Dr. O. P. Jenkins and myself, I hesitated to regard the specimens which we collected at Red Rock and Dillon as being new, and identified them as *Catostomus discobolus* Cope.

The narrow fontanelle and the cartilaginous sheath of the lower lip, together with the uncertainty as to the exact locality from which Prof. Cope's types came, seemed to favor this identification. Upon the suggestion of Dr. Jordan that the types of *C. discobolus* were probably the young of *C. latipinnis* and that my specimens were probably an undescribed species, I was induced to make a reëxamination of the question. This was particularly desirable in view of the fact that so much additional material had resulted from my recent explorations in the Black Hills.

Prof. Cope's types of *Catostomus discobolus* consisted of "two specimens, one certainly, the other probably, from the Green River, Wyoming,"* and can not now be found, but there are twelve specimens from the Colorado Basin in the National Museum under the name *C. discobolus*, presumably identified as such by Prof. Cope. These are quite certainly young specimens of *Pantosteus delphinus*, and I am inclined to the belief that the types of *C. discobolus* were also the young of this species rather than the young of *C. latipinnis*. Should this be the case, the species would stand as *Pantosteus discobolus* (Cope), *discobolus* having priority over *delphinus*.

While this question can not be definitely determined, Prof. Cope's description of *C. discobolus* applying equally well to *C. latipinnis* and *P. delphinus*, the probabilities are strongly in favor of this view, and I therefore adopt the name *discobolus* instead of *delphinus* for the *Pantosteus* of the Colorado River.

As remarked elsewhere in this paper, all the other specimens in the Museum which have been called *C. discobolus* (and which are from Lapwai Creek, Idaho), are undoubtedly young specimens of *C. catostomus*.

An examination of the air bladder in several species of suckers shows marked differences. In all species of *Pantosteus* examined (*P. generosus*, *plebeius*, *discobolus* and *jordani*) the air bladder is quite small, the first (anterior) compartment being quite short, while the second is very long and slender, usually 2½ to 3 times the length of the first.

In one specimen of *P. discobolus* the air-bladder was large, but this specimen had been previously cut open and examined by some one; the air bladder was detached, and may possibly belong to another fish.

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*Hayden's Geological Survey of Wyoming, 4th Annual Report, 1870, 435.

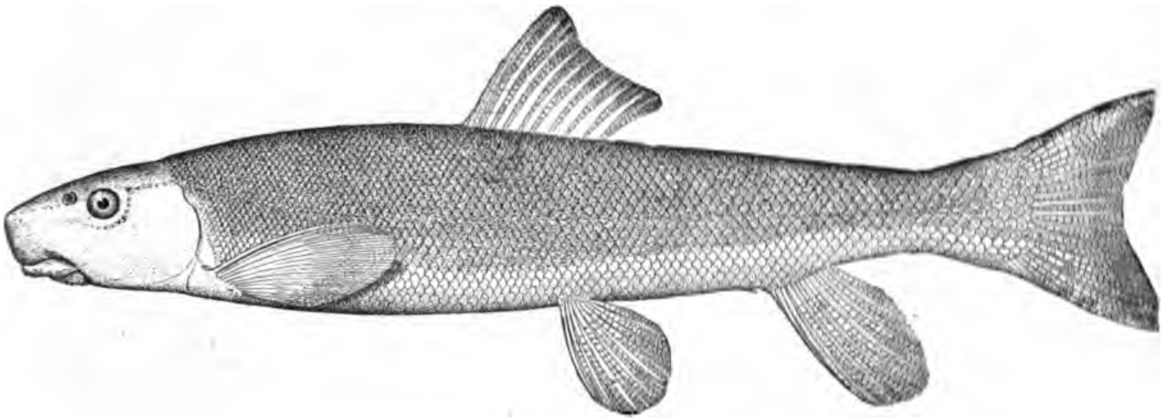
In all species of *Catostomus* examined (*C. latipinnis*, *catostomus*, *ardens*, and *griseus*), the air bladder is large, very much larger than in any *Pantosteus* and very different in appearance except in *C. latipinnis*, in which the air bladder greatly resembles that of *Pantosteus*.

Pantosteus jordani is rather intermediate in its structure between *Pantosteus* and *Catostomus*, but, on the whole, its characters indicate a closer relationship with the species of the former genus, in which it should be placed if *Pantosteus* and *Catostomus* are to be regarded as generically distinct, the propriety of which is doubtful. The high development of the cartilaginous sheath is a character possessed by all the species of *Pantosteus* and is not found among the species of *Catostomus*, except in *C. catostomus*, where it is more pronounced than in any other species of that genus.

The entire obliteration of the fontanelle, even in the most typical species of *Pantosteus*, is a question of age, the fontanelle being more or less evident as a very narrow slit in the young of all the species of which the young are known.

Pantosteus jordani is, on the one hand, most closely related to *Pantosteus virescens* Cope and *P. discobolus* (Cope), while on the other it resembles *C. catostomus* (Forst.). It is the most abundant and most generally distributed species of the family in the streams flowing from the Black Hills, and frequents the clear, colder, and swifter parts of the streams. With the exception of Hat Creek, all the streams in which it has been found are clear and cold. We did not find it at all in the South Fork of the Cheyenne nor in the Loup or Beaver Creek at Ravenna. It is apparently a fish of small size which delights in the upper reaches and colder, clearer portions of the smaller mountain streams of the Upper Missouri basin.

I name this interesting species for my teacher and friend, President David Starr Jordan, of Leland Stanford Junior University.



PANTOSTEUS JORDANI sp. nov. *Jordan's Sucker.* About four-fifths natural size.

In connection with my study of this species I was led to an examination of all the specimens of *Pantosteus* and the related species of *Catostomus* to be found among the collections now in the U. S. National Museum. Dr. Jordan, in his Catalogue of Fishes of North America, published in 1885, recognized but three species of *Pantosteus*, viz, *plebeius*, *generosus*, and *guzmaniensis*, and expressed the opinion that *Minomus bardus* and *M. delphinus* of Cope should be considered identical with *P. plebeius*, and further, that *P. virescens* Cope is the same as *Acomus guzmaniensis* Girard.

The collections made in 1889 in Colorado and Utah by Dr. Jordan and myself contain numerous specimens of *Pantosteus* from the Rio Grande, Colorado, and Utah basins, the study of which led Dr. Jordan to admit the three species, *P. plebeius*, *generosus*, and *delphinus*. He at this time regarded *Acomus guzmaniensis* as identical with *P. plebeius*, and *P. virescens* as being probably the same as *P. delphinus*.

These collections of 1889 suggested the strong probability of the limited distribution of each species of this genus, and that each is likely confined to a single hydrographic basin. My examination of the types of all the nominal species now to be found, and the comparison with them of all the other material obtainable, confirm this view. I can see no differences of any value among the specimens from the different places in the Rio Grande basin, and must regard them all as being identical with Baird and Girard's *Catostomus plebeius*, the types of which came from the Rio Mimbres, a tributary of Lake Guzman, which is in the Rio Grande basin. All the specimens from the Colorado basin are easily referable to *P. delphinus* (Cope), while all those from the Utah basin are with equal certainty *P. generosus* (Girard).

The only specimen from the Arkansas basin is the type of Cope's *P. virescens*, which is said to have been taken in the Arkansas River at Pueblo, Colo. This specimen is about 14 inches in total length, and is in good condition. It is most closely related to *P. discobolus*, and, like that species, has a slender caudal peduncle and very small scales, which I count as 17–103–16, and 45 before the dorsal. I am not sure that this is really distinct from *P. discobolus*, and doubt if the specimen came from the Arkansas River.

The synonymy of the species of *Pantosteus* should stand as follows:

PANTOSTEUS PLEBEIUS (B. & G.).

Catostomus plebeius B. & G., Proc. Acad. Nat. Sci. Phila. 1854, 28 (Rio Mimbres, tributary of Lake Guzman, Chihuahua); Agassiz, Am. Jour. Sci. & Arts, 2d series, xix, 208, 1855.

Minomus plebeius, Grd., Proc. Acad. Nat. Sci. Phila. 1856, 173 (Rio Mimbres, Chihuahua); *ibid.*, U. S. and Mex. Bound. Survey, 1858, 38, pl. xxiii, figs. 6–10 (Rio Mimbres, Chihuahua).

Catostomus plebeius, Gunther, Cat. Fishes, vii, 15, 1868 (Rio Mimbres).

Pantosteus plebeius, Jordan & Gilbert, Synopsis, 122, 1883 (Lake Guzman); Jordan, Bull. U. S. F. C., ix, for 1889 (1891), 19 (Rio Conejos, Colo., and Rio Grande at Del Norte and Alamosa, Colo.).

Catostomus (*Acomus*) *guzmaniensis* Grd., Proc. Acad. Nat. Sci. Phila. 1856, 173 (Janos River, tributary of Lake Guzman, Chihuahua).

Acomus guzmaniensis Grd., U. S. and Mex. Bound. Survey, 1858, 39, pl. xxiii, figs. 6–10 (Janos River, Chihuahua).

Catostomus guzmaniensis, Gunther, Cat. Fishes, vii, 15, 1868 (Janos River, Chihuahua).

Pantosteus jarrovii, Cope and Yarrow, Zoölogy Wheeler Survey, v, 674, pl. xxix, figs. 2 and 2*a*, 1875, only in part (San Ildefonso and Taos, New Mexico).

Habitat: Rio Grande Basin.

PANTOSTEUS VIRESCENS (Cope).

Pantosteus virescens Cope, Zoöl. Wheeler Survey, 1875, 675 (Arkansas River, Pueblo, Colo.); *ibid.*, Jordan & Copeland, Check List, 1876, 156; *ibid.*, Jordan, Bull. U. S. Geol. Surv. Terr., iv, 416, 1878 (Arkansas River).

Habitat: Arkansas River.

PANTOSTEUS GENEROSUS (Grd.).

Catostomus (Acomus) generosus Grd., Proc. Acad. Nat. Sci. Phila. 1856, 174 (Cottonwood Creek, Utah).
Acomus generosus Grd., P. R. R. Survey, 1858, 221 (Cottonwood Creek, Utah).
Catostomus? generosus, Cope, Plagopterinæ and Ichthyol. of Utah, 1874, 7 (Provo, Utah); *ibid.*, Jordan and Copeland, Check List, 1876, 156.
Pantosteus generosus, Jordan, Bull. XII, U. S. Nat. Mus., 1878, 183 (Great Basin of Utah); *ibid.*, Jordan and Gilbert, Synopsis, 1883, 123 (only in part); *ibid.*, Jordan, Cat. Fish. N. A., 1885, 17; *ibid.*, Bull. IX, U. S. Fish Com. for 1889 (1891), 32 and 35 (Jordan River, Sevier River, and Utah Lake).
Minomus platyrhynchus Cope, Proc. Am. Philos. Soc. Phila. 1874, 134 (Provo, Utah); *ibid.*, Plagopterinæ and Ichthyol. of Utah, 1874, 6 (Provo, Utah).
Pantosteus platyrhynchus, Cope & Yarrow, Zoöl. Wheeler Survey, 1875, 673, pl. XXIX, figs. 3 and 3a (Provo River, Utah); *ibid.*, Jordan & Copeland, Check List, 156, 1876; *ibid.*, Bull. XII, U. S. Nat. Mus., 1878, 183 (Utah Lake and tributaries); *ibid.*, Jordan & Gilbert, Synopsis, 1883, 123 (Utah Lake).
Minomus jarrovii Cope, Proc. Am. Phil. Soc. Phila. 1874, v. 139-139 (Provo, Utah).
Pantosteus jarrovii, Jordan & Copeland, Check List, 1876, 156.
Catostomus guzmaniensis, Cope & Yarrow, Zoöl. Wheeler Survey, 1875, 679 (Utah Lake).

Habitat: Great Salt Lake Basin.

PANTOSTEUS DISCOBOLUS (Cope).

Catostomus discobolus Cope, Hayden's Geol. Survey of Wyo., 1870, 435 (two specimens, one certainly, the other probably, from Green River, Wyoming).
Minomus delphinus Cope. Hayden's Geol. Survey of Wyo., 1870, 435 (probably from Green River).
Pantosteus dolphinus, Jordan & Copeland, Check List, 1876, 156 (misprint for *delphinus*).
Pantosteus delphinus, Jordan & Gilbert, Synopsis, 1883, 122 (probably from Green River); *ibid.*, Jordan, Bull. IX, U. S. Fish Comm. for 1889 (1891), 27 (Eagle River, Gypsum, Colo.; Gunnison and Uncompahgre rivers, Delta, Colo.; Rio de las Animas and Rio Florida, Durango, Colo.).
? *Minomus bardus* Cope, Hayden's Geol. Survey of Wyo., 1870, 436 (probably Green River).
Pantosteus jarrovii, Cope & Yarrow, Zoöl. Wheeler Survey, 1875, 674, *in part only* (Zuñi River, N. M., and Tierra Amarilla, N. M. The figures, pl. XXIX, 2 and 2a, are *P. plebeius*).
Catostomus discobolus Cope, Proc. Am. Philo. Soc. Phila. 1874, 138; *ibid.*, Plagopterinæ and Ichthyol. of Utah, 1874, 10 ("Zuñi River, Arizona;" "Arizona"); *ibid.*, Cope & Yarrow, Zoöl. Wheeler Survey, 1875, 677 (Zuñi River, N. M.; "Arizona").

Habitat: Basin of the Colorado River.

In the appended table is given a list of all the specimens of *Pantosteus* that can now be found in the U. S. National Museum, together with my identification of each.

All the specimens which have been called *P. jarrovii* that I have been able to find are apparently from the Rio Grande and Utah basins, those from the former being *P. plebeius* and those from the latter *P. generosus*.

Those reported by Cope and Yarrow from the Zuñi river, New Mexico, can not be found, but were most likely *P. discobolus*, which is known to occur there.

There are seven bottles of suckers in the Museum, labeled *Catostomus discobolus*. Three of these lots are from the Colorado Basin and are almost certainly young specimens of *P. discobolus*. They have been regarded by Dr. Jordan as the young of *Catostomus latipinnis*; but I find, upon comparing them with small specimens of *latipinnis* from the Uncompahgre and Sevier rivers, that the fontanelle is more nearly obliterated, the lower lip is broader and less deeply incised, and the cartilaginous sheath much more developed than in *latipinnis*. Furthermore, they are not distinguishable by me from specimens of what has been called *P. delphinus* of the same size from the Uncompahgre River. The cartilaginous sheath is quite as well developed, the scales are equally small, and the fontanelle is as imperfect.

All the other specimens in the Museum labeled *Catostomus discobolus* were collected by Capt. Bendire, in Lapwai Creek, Idaho, which is in the Snake River Basin, and are undoubtedly the young of *Catostomus catostomus*.

The specimens collected at Amarilla, N. Mex., by Dr. Yarrow have the caudal peduncle a little deeper than in other specimens of *discobolus* with which I have compared them, but they are certainly not *generosus;* they may possibly be *plebeius*, but are most likely *discobolus*.

According to this view, Prof. Cope's types of *P. jarrovii* from the Rio Grande are *plebeius*, those from the Utah basin are *generosus*, and those (if any) from the Colorado basin are *discobolus*. All these specimens are small and some of them, particularly those said to be from Zuñi, are in such poor condition as to render certain identification impossible. It is possible that the locality labels have been confused.

In *P. discobolus* the lower lip is somewhat broader and the tubercles smaller than in *plebeius* and *generosus*. It bears a close external resemblance to *C. latipinnis*, especially in the general shape of the body, the slender caudal peduncle, and the small, subequal scales, but the eye is smaller.

List of specimens of Pantosteus now found in U. S. National Museum.

Nat. Mus. No.	No. of specimens.	When collected	Collector.	Locality.	Name under which entered in National Museum.	Identification.
20913	16	1873	Dr. H. C. Yarrow	"Amarilla, N. Mex"	Pantosteus generosus, part of the types of P. jarrovii.	Pantosteus discobolus.
16758	1	1874	C. E. Aiken	Arkansas River, Pueblo, Colo.	Pantosteus guzmaniensis, type of P. virescens.	Pantosteus virescens.
15763	4	1872	Yarrow & Henshaw	Provo, Utah	Pantosteus generosus, types of P. platyrhynchus.	Pantosteus generosus.
168	1	1851	J. H. Clark	Rio Mimbres, Lake Guzman, Chihuahua.	Pantosteus plebeius (type of Catostomus plebeius).	Pantosteus plebeius.
168	5	1851	do	Rio Mimbres, Lake Guzman.	Pantosteus plebeius, types	Do.
27080	30	1874	Dr. H. C. Yarrow	"Rio Grande, Il de Fonso."	Pantosteus generosus, part of types of P. jarrovii.	Do.
18008	5	1874	Cope & Shedd	Nutrias, Colo	Pantosteus generosus, part of types of P. jarrovii. (?)	Do.
18009	9	1874	Dr. H. C. Yarrow	"New Mexico"	Pantosteus generosus, part of types of P. jarrovii.	Do.
18011	35	1874	do	do.	do.	Do.
5910	1		Lieut. Beale	Ojo de Gallo, N. Mex.	Pantosteus generosus	Do.
(3029) 41645	13	1889	Jordan & Evermann	Rio Grande, Alamosa, Colo.	Pantosteus plebeius	Do.
(3047) 41659	13	1889	do	Rio Conejos, Alamosa, Colo.	do.	Do.
15783	4	1873	H. W. Henshaw	Zuni, N. Mex	Catostomus discobolus	Pantosteus discobolus.
12914	4	1873	Dr. C. G. Newberry	"Arizona"	do.	Do.
15791	4	1873	do	do	do	Do.
12906	3	1872	Yarrow & Henshaw	Provo, Utah	Pantosteus generosus, part of the types of P. jarrovii.	Pantosteus generosus.
15802	1	1873	H. W. Henshaw	Zuni, N. Mex. (Locality probably wrong.)	do	Do.
30807	1	1881	P. Madsen	Utah Lake	Pantosteus generosus	Do.
30807	1	1881	Jordan & Madsen	Utah Lake, Provo, Utah.	do	Do.
260	2	1854	Dr. C. B. Kennerly	Rio Janos, Lake Guzman, Chihuahua.	Pantosteus guzmaniensis (type of Acomus guzmaniensis).	Pantosteus plebeius.
256	3	1854	Lieut. E. P. Beckwith.	Cottonwood Creek, Utah.	Pantosteus generosus (type of Acomus generosus).	Pantosteus generosus.
F. C. (3006) 41624	25	1889	Jordan & Evermann	Provo, Utah	Pantosteus generosus	Do.
(3027) 41631	5	1889	do	Uncompahgre River, Delta, Colo.	Pantosteus delphinus	Pantosteus discobolus.
(3020) 41627	15	1889	do	Jordan River, Utah	Pantosteus generosus	Pantosteus generosus.

WASHINGTON, *January 25, 1893.*

3.—THE FISHES OF TEXAS AND THE RIO GRANDE BASIN, CONSIDERED CHIEFLY WITH REFERENCE TO THEIR GEOGRAPHIC DISTRIBUTION.

BY BARTON W. EVERMANN AND WILLIAM C. KENDALL.

INTRODUCTION.

During the months of November and December of 1891, Prof. Evermann was engaged, under the direction of the Commissioner of Fish and Fisheries, Col. Marshall McDonald, in making certain investigations looking toward the establishment of a fish-cultural station at some point in the State of Texas. While carrying on these investigations, extensive collections of fishes were made at various places, particularly at Galveston and Corpus Christi on the coast, and in the vicinity of Houston, Palestine, San Antonio, New Braunfels, and San Marcos in the interior. The report[*] upon the specific object of this work was published May 25, 1892. This report contained, in addition, the results of the studies of the species of *Cyprinidæ* and *Cyprinodontidæ* contained in the collections. Other duties in connection with the fur-seal investigations in the North Pacific and Bering Sea have delayed until now the completion of the report upon the remaining species. When these came to be studied, it was decided to bring together all that is known to date regarding the fishes of Texas and the Rio Grande Basin, particularly respecting their geographic distribution in that region. The present paper has, therefore, been made to include all the species, both salt and fresh water, which have ever been reported from that region, so far as we have been able to learn. Geographically, the paper is made to include not only the State of Texas, but all those portions of Colorado, New Mexico, and Mexico which belong in the hydrographic basin of the Rio Grande.

THE GEOGRAPHY OF TEXAS.

EXTENT.

The area of Texas is 265,780 square miles, which is about 9 per cent of the entire United States. Texas is equal to the combined areas of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and Ohio, and is nearly 2¼ times as large as all Great Britain and Ireland. It is over 800 miles in greatest length and is nearly as wide from east to west. Its greatest length is as great as the distance from Boston to Chicago, Chicago to Cheyenne or to Mobile, or from New York to Jacksonville, Fla. The resident of the western part of Texas is nearer San Diego, Cal., than to his own State capital, or more than 200 miles closer to the Pacific than to the Gulf of Mexico. It extends through more than 10 degrees of latitude (25° 50′ to 36° 30′ N.) and through more than 13 degrees of longitude (93° 20′ to 106° 40′ W.).

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[*] Report of the Commissioner of Fish and Fisheries respecting the establishment of Fish-Cultural Stations in the Rocky Mountain Region and Gulf States. Senate Mis. Doc. No. 65, Fifty-second Congress, first session. Pages I to IV and 1 to 88; plates I to XXXVI. [This report was subsequently reprinted as Articles 1 and 2 of the Bulletin of the U. S. Fish Commission for 1891.]

CLIMATE.

The climatic conditions presented by a region so vast as this must necessarily be very diverse. The State has been divided into five climatic and topographic divisions, as follows:

1. *The coast plain region.*—This includes a strip along the coast and extending back from 150 to 200 miles, the western boundary being marked approximately by a line drawn through Laredo, San Antonio, Austin, Palestine, and Texarkana. Immediately along the coast it is more or less marshy, and the elevation nowhere probably exceeds 500 feet. This region receives an abundance of rainfall; at Galveston it amounts to 52 inches and at Palestine to 47 inches.

2. *The black prairie region.*—This is a narrow belt running parallel with the coast plain, and is chiefly characterized by the rich black soil of the undulating prairie. The elevation is 300 to 700 feet, and the mean annual rainfall is probably not over 35 inches.

3. *The central region.*—The central region extends westward from the longitude of Denison to the eastern escarpment of the Llano Estacado and southwest to the mountains of the Trans-Pecos region. In its northern part are forests of stunted growth called "cross timbers," which lie between the Red and Brazos rivers. Westward, between the one hundredth meridian and the escarpment of the Llano, are the "red beds," a gypsiferous region not unlike that just east of the Black Hills in South Dakota. The southern portion of the central is a broken country of limestone formation, and in some parts devoid of streams. The altitude of this region is from 700 to 2,500 feet, and the annual rainfall is probably about 25 inches.

4. *The Llano Estacado.*—The Staked Plains extend from near the Canadian River on the north to the thirty-second parallel on the south. This is an immense plateau with a gentle inclination from northwest to southeast. The elevation above the Gulf is from 2,600 to 4,800 feet. They extend from the Pecos region in New Mexico eastward to near the one hundred and first meridian, where they are terminated by a bold escarpment on the northeast, east, and southeast. On the eastern side extensive canyons penetrate the Plains to various distances, running from northwest to southeast, in a line with the dip of the strata. The Colorado, Brazos, and Red rivers all have their sources in the Plains with numerous branches extending into them a greater or less distance, some of them as far as 100 miles. These canyons are the work of erosion, and no greater force was required than that now at work. When once the upper stratum is broken and the water begins to flow over the soft beds below, the channel is cut deeper each year until the present deep canyons have resulted; all have flowing streams in them, coming from the water-bearing stratum lying at the bottom of the Tertiary formation. The sides of these canyons are usually precipitous, and they are consequently difficult to cross. At various places in the Plains are permanent lakes of greater or less area, some fresh and some salt. Besides these there are numerous depressions or basins in which water collects during the rainy season and remains for several months. These lakes often cover several hundred acres.

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All the rivers along the eastern side of the Plains are supplied from springs, mostly from the base of the Cretaceous and Tertiary, but in some instances from the Triassic. Many of these springs are quite large and in them are found some fishes. The streams running from them, in many cases, entirely disappear in the ground during the dry season, while others dry up, except in places where the water stands in holes or deep pools, in some of which fishes, such as catfish, sunfish, cyprinoids, and cyprinodonts, are found in abundance. It has been estimated that not less than 13,000,000 gallons of water flow over the falls of White River daily, yet nearly the entire amount sinks into the ground within a few miles below the falls.

The soils of the Staked Plains have been derived principally from the underlying materials of the late Tertiary. In late Tertiary times the region where the Staked Plains now are was an inland sea, bounded on the east and south by the Cretaceous formation, and on the west by the range of mountains west of the Pecos River. During the early part of this Tertiary time there was great erosion of the Cretaceous and Triassic, and this material of sand and clay was deposited in this inland Tertiary sea until finally, when it was drained of its waters, there was left a series of beds of this Tertiary material varying from 10 to 12 feet on the south to 300 feet on the north, composed of sandy clays in alternate beds of stratification, but none of them so compact as to be impervious to water. Whenever these strata are exposed to atmospheric influences their material readily disintegrates and forms a soil quite homogeneous throughout the entire area of the Plains. This soil is composed chiefly of sand and clay with considerable alkali, and, being easily eroded, of course materially affects the purity of the streams during the rainy season. While there is but little woody vegetation on the Llano, the region is by no means a desert—bunch, gramma, and mesquit grasses grow with luxuriance and render the Plains valuable for grazing.

The following table gives the temperature at three different places on the Plains:

*Table showing annual mean temperature on the Staked Plains in Texas.**

Station.	Elevation.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Fort Elliott	2,500	30.6	36.0	46.0	55.6	63.8	73.0	77.0	74.7	68.2	56.8	42.5	34.4	54.8
Mount Blanco	3,800	43.7	46.3	54.3	61.0	72.6	76.8	78.9	81.0	73.0	61.2	50.6	40.6	61.7
Midland	2,775	39.3	46.9	52.1	64.3	77.5	80.0	84.2	81.1	73.3	61.5	48.6	41.7	62.3

The annual rainfall is about 20 inches, the greater part of which falls during the summer months. The season of greatest drought is during the winter months.

5. *The Trans-Pecos region.*—This embraces all that portion of Texas lying between the Pecos and the Rio Grande, and has an average width of about 150 miles and an average length of over 250 miles; its area is, therefore, considerably greater than that of the State of Maine. The only true mountains in Texas are in this region, the principal ranges being the Guadalupe, Limpia, and Quitman mountains. The general elevation is 3,000 to 5,000 feet above the sea, but some peaks rise much higher. Guadalupe Peak is 9,000 feet and Limpia Peak 8,000 feet. The summits of most of these mountains are covered with a good growth of timber, the principal trees represented being three species of pine (*Pinus ponderosa*, *P. flexilis*, and *P. edulis*), some of which grow to good size.

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*For this table and much of what is here given regarding the climate and geography of the western part of Texas we are indebted to the various reports of the Texas Geological Survey.

The Trans-Pecos region is said to be poorly watered; the annual rainfall is probably less than 20 inches (not over 13 inches at El Paso), and the streams are small and periodic in their flow. There are a good many springs in various parts of the region whose waters do not in every case reach the Pecos or the Rio Grande, but are lost in the ground or by evaporation.

It thus appears that, climatically as well as geographically, Texas is almost all kinds of a State. While the coastal region receives an abundance of rainfall, there is a gradual decrease in the amount of precipitation as we go westward. From a mean annual rainfall of 52 inches at Galveston on the coast, the decrease is more or less gradual until at El Paso, in the most western part of the State, the amount does not exceed 13 inches. The records also show considerable variation in different years, the amount sometimes falling as low as 10 inches in the western part of the State.

The temperature of course varies greatly in different sections of the State. Fort Ringgold, situated on the Rio Grande something over 100 miles above its mouth, has the reputation of being the hottest place in the United States except, perhaps, Fort Yuma and Key West. The mean annual temperature at Fort Ringgold is about 73°, at El Paso 63°, at Galveston 70°, and at Fort Elliott 54°.

The prevailing winds are southerly or southeasterly, and blowing constantly across the State do much toward rendering the summers endurable even in the hottest parts of the State.

VEGETATION.

The flora of Texas is greatly diversified. In the northeast and eastern portions there are heavy pine forests, like those of the neighboring States of Louisiana and Arkansas. This does not extend, however, much beyond the Colorado River, and only on its lower course. In the vicinity of Galveston, or rather back from Galveston some miles, there is considerable timber along the streams and an occasional pine forest. Among the trees seen near Nicholstone are pine, three species of oak, elm, cedar, mulberry, ash, box-elder, hackberry, cherry, and holly; one of the most striking features of the flora here is the vast amount of Spanish moss (*Tillandsia usneoides*) covering the oaks along Dickinson Bayou. Most of these species of trees were seen also about Houston. The pine forests, however, were more extensive about Houston and along Clear Creek, where were to be seen a good many magnolias and an occasional persimmon tree. The Spanish moss was less common here than at Nicholstone.

The Black Prairie belt has few trees except along the streams, where there is a good growth of cottonwood, pecan, cypress, oaks, and numerous species of shrubs. About San Marcos, New Braunfels, and San Antonio these trees are abundant. The oaks and other trees situated in the valleys along the streams were thickly overgrown with *Tillandsia usneoides*, but on the higher lands about New Braunfels and between San Antonio and Corpus Christi there are considerable clumps of oaks which are profusely covered with another epiphyte, *Tillandsia recurvata*. West of the Black Prairie the timber is scrubby and of little value except for fuel. The river valleys do not differ materially from those parts lying in the Black Prairie region.

Below El Paso the valley of the Rio Grande widens out into a great plain, which is covered near the river with cottonwoods, willows, and a species of ash.* On the higher ground the mesquit is abundant and the screw-bean (*Prosopis pubescens*) or *tornillo* of the Mexicans is very common. Further down the Rio Grande the cottonwoods become less abundant, but the mesquit and the other shrubby vegetation increase, while still lower down the valley black willow (*Salix niger*), the long-leafed willow (*Salix longifolia*), water elm (*Ulmus crassifolia*), green ash (*Fraxinus berlandieriana*), which grows 2 to 3 feet in diameter and 40 to 50 feet high, and several other species of smaller trees and shrubs are abundant. On the lower Rio Grande and along the coast toward Corpus Christi are but few trees or bushes of any considerable size. The most important are the shrubby mesquit, huisache (*Acacia farnesiana*), retama (*Parkinsonia aculeata*), ebony, Texas persimmon, hackberry, and black willow. This is the region of the chaparral, great areas being covered with a scraggy, interlocking mass of shrubs all more or less thorny, or with stiff, spiny branches, the whole being almost impenetrable. According to Dr. Havard the principal species represented are mesquit, granjeno, Texas persimmon, junco (*Kœberlinia spinosa*), coyotillo, *Acacia amentacea*, *Acacia flexicaulis*, *Condalia obotrifoliata*, *Castela nicholsoni*, *Xanthoxylum pterota*, *Lippia lycioides*, *Berberis trifoliata*, and *Lantana camara*. Among and over these grow such vines as *Anredera scandens*, *Vitis incisa*, *Serjania brachycarpa*, and *Maximowiczia lindheimeri*.

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*Most of the facts regarding the vegetation of this region have been taken from Dr. Havard's valuable Report on the Flora of Western and Southern Texas. Proc. U. S. Nat. Mus., 1885, 449–533.

Cactaceæ are of course abundant nearly everywhere on the uplands of Texas. Among the more common are several species of *Mamillaria* (*macromeris*, *meicantha*, *tuberculosa*, and *heyderi*), the strawberry cactus (*Cereus stramineus*), other species of *Cereus* (*chloranthus*, *paucispinus*, and *enneacanthus*), three species of *Echinocactus* (*longehamatus*, *horizonthalonius*, and *intertextus*), and several species of *Opuntia* (such as *frutescens*, *arborescens*, and *grahami*). Another conspicuous plant of southwestern Texas is the Mexican *lechuguilla* or *agave* (*Agave heteracantha*), which is found covering the limestone regions of that part of the State in impenetrable masses. The Texas mescal (*Agave wislizeni*) and the Mexican maguey (*Agave americana*) are also common and conspicuous plants in this region. On the high mesa lands of southern and western Texas (but not on the Llano Estacado) the Spanish bayonet (*Yucca baccata*) is abundant; in places it grows to a height of 25 to 30 feet, is a foot or more in diameter, and is the most characteristic plant of the wide slopes leading up to the bases of the mountains.

DRAINAGE.

Texas is drained by the Arkansas, the Red, and the Rio Grande, together with a large number of smaller streams which reach the Gulf at various points along the 400 miles of coast line which the State possesses. The Rio Grande and the Arkansas have their headwaters not far from each other in a limited district in Colorado and New Mexico, but they reach the sea through mouths a thousand miles apart. The most northern counties in the Panhandle of Texas are drained by the North Fork of the Canadian River, while those lying next south are drained by the South Fork of the Canadian, both belonging to the Arkansas system.

The portion of the State which belongs to the Arkansas basin has an area of about 12,000 square miles. The South Fork of the Canadian rises in the Rocky Mountains, in the northeastern part of New Mexico not far from the headwaters of the Pecos, and flows entirely across the Panhandle in the northern part of the Llano, through which it has cut a deep canyon. This river is about 900 miles long, but is in most of its course a rather shallow stream.

The Red River is by far the most important stream of northern Texas. It has its sources in the northern and northeastern portions of the Llano Estacado, forms the northern boundary of Texas through six degrees of longitude (from the one hundredth to the ninety-fourth meridian), and has a total course of more than 1,600 miles. Its hydrographic basin contains over 97,000 square miles, the greater part of which, however, is outside of Texas. Most of the upper heads of the Red River in the Panhandle are said to afford a constant supply of good pure water, and some of them are well shaded with cottonwoods. Further down much of the water sinks in the ground or is lost by evaporation, and the stream becomes small or even dry at times. There is also less timber along this part of its course. Its principal tributaries here are the Pease and Big Wichita rivers, which rise near the eastern escarpment and run through arid, treeless plains with occasional clumps of hackberry, willow, and cottonwood in the side canyons. The Big Wichita is said to be well timbered, however, near its mouth. Below the mouth of the Big Wichita, the southern tributaries of the Red River are all very short and unimportant, the divide between the Red River basin and those of the Sabine, Trinity, and Brazos being well up toward the Red. The only stream of any importance which the Red River receives from Texas below the Wichita is Sulphur River in the extreme northeast part of the State, and which is about 200 miles long. The Red River is subject to great variation in the amount of water which it carries, according to the rainfall. In winter and spring it is frequently a raging torrent of muddy water spreading far beyond its banks, while in the fall it is reduced to a stream of insignificant proportions in its upper and middle portions.

The Sabine River, which forms the eastern boundary of Texas for about 200 miles, is an important stream 500 miles long, having its rise in the northeastern part of the State only a few miles from the Red River.

The Neches, San Jacinto, Trinity, Brazos, Colorado, Guadalupe, San Antonio, and Nueces rivers are the principal streams of Texas which lie wholly within the State. All of these rise in the central or western part of the State and flow southeast in approximately parallel courses to the Gulf of Mexico. The Trinity, Brazos, and Colorado are each about 1,000 miles long and are streams of much importance; like all the others of this State, however, they are subject to great floods and periodic droughts. In the Cretaceous limestone belt running through the State near San Antonio, New Braunfels, San Marcos, and Austin are found numerous springs of enormous size. Each of the cities just named has in its immediate vicinity one or more of these remarkable springs. The temperature of the water in all these springs seems to be about the same and does not vary greatly from 75° throughout the year.

In the narrow Quaternary belt of the coastal region are numerous short tidal streams, usually locally known as bayous. These are frequently quite deep and are navigable for small boats for much of their length. Their banks are generally well wooded and their waters well filled with the species of fish common to lowland, coastal streams. About their mouths are found many of the most important food-fishes of the coast. The water in these bayous is usually warm, frequently quite muddy, and always more or less stained from the vegetation growing in it. The shores and bottoms are in most places made up of soft mud, and snags and logs are abundant.

The Rio Grande del Norte, or the Rio Bravo of the early Mexicans, is in many ways a remarkable river. Having its sources in the San Juan Mountains of Colorado only a few miles from some of the sources of the Arkansas and the Colorado of the West, it flows east to San Luis Park, then south through the whole length of New Mexico, which it divides into nearly equal parts. Upon leaving New Mexico it turns to the southeast, which general direction it maintains until it reaches the Gulf of Mexico in latitude 26° north and longitude 97° west, approximately. The total length of this river is about 1,800 miles, and it forms the entire boundary between Texas and Mexico, a distance of more than 1,000 miles and considerably more than half of the entire length of the boundary between the United States and Mexico. The tributaries in the San Juan Mountains are all clear, cold streams, excellent for trout, but in the San Luis Park and below the stream is more shallow, the water is warmer and less pure, and trout disappear. Still farther down, except at a few places where the stream has cut through low mountains or hills and is confined in a narrow canyon, the river widens greatly, becomes very shallow, and has a bed of shifting sand and mud. Much of the country drained by the Rio Grande has an adobe soil which contains a large amount of alkalies, and the water of the river is not only more or less alkaline, but contains much solid matter in suspension or other mineral matter in solution. This of course renders the water objectionable to many species of fishes. The Rio Grande is, however, much purer above the mouth of the Pecos than it is below, owing to the fact that the Pecos flows through softer strata containing a larger percentage of salt and gypsum.

From Bulletin 3 of the Texas Geological Survey the following facts are taken. The banks of the Pecos River are lined with incrustations of salt left by the evaporation of the river water, and present a very white appearance. The sides of canyons along the river are similarly incrusted and salt appears in spots over the ground.

The following table contains the analyses of two samples of Pecos River water, made by the chemist of the Texas Geological Survey. No. 1 was collected at Pecos City and received at the laboratory in January, 1889; it gave an alkaline reaction on boiling, and had an alkaline taste; suspended matter made up largely of red silt, which settled quickly on standing. No. 2 was collected in Reeves County and received by the chemist in December, 1889; gave an alkaline reaction and possessed an alkaline taste; suspended matter made up more of silt and lighter soil than in No. 1, and settled only after 24 hours' standing:

Analyses of Pecos River water.	Grains per gallon.	
	No. 1.	No. 2.
Total solid matter	[illegible]	[illegible]
Soluble after evaporation	[illegible]	[illegible]
Total mineral matter	[illegible]	[illegible]
Total lime, as CaO	[illegible]	[illegible]
Total sulphuric acid, as SO_3	[illegible]	[illegible]
Total chlorine	[illegible]	[illegible]
Total alkalies as chlorides	[illegible]	[illegible]
Total potash, as oxide	*	[illegible]
Total soda, as oxide	*	[illegible]
Total suspended matter	[illegible]	[illegible]

* Not separated.

It is not stated just when these samples were collected, but presumably No. 1 was taken in January and No. 2 in December, when the river was low.

The following analysis of the Rio Grande water is given in the same bulletin, but it is not stated just when or where the sample was obtained:

Analysis of Rio Grande water.	Grains per gallon.
Suspended matter (inorganic)	98.65
Total residue in clear water	40.65
Organic and volatile matter	5.05
Total soluble matter	29.15
Lime	4.65
Sulphuric acid (anhydrous)	3.23
Alkaline chlorides	1.77
Silica, iron, and alumina not determined	....

This water when collected was very muddy, hence the large amount of suspended inorganic matter. The area of the Rio Grande basin is about 240,000 square miles. The only tributaries of any size from the United States are the Pecos and Devil rivers. The Pecos rises in New Mexico and runs approximately due south, then southeast for about 800 miles, the greater part of which distance is through an arid table land nearly destitute of timber. Devil River is a much smaller stream which empties into the Rio Grande several miles below the mouth of the Pecos, and which is said to be a much clearer, colder stream than the other rivers of Texas. The most important affluents which the Rio Grande receives from the Mexican side are the Rio de las Conchas, Rio Salado, Rio Sabinas, and Rio San Juan. Of these the Conchas is by far the largest, and is about 300 miles long.

Beginning as far up the Rio Grande as Wagonwheel Gap and Del Norte in Colorado, and extending down the stream and on its principal tributaries, are found numerous irrigation ditches, many of which are of enormous size. The demands of these ditches are so great that during the season of growing crops the Rio Grande is almost wiped out of existence and is left in many portions of its course only as a wide sandy river bed with but little running water. This very seriously affects the fishes. At Del Norte, Colo., in 1889, I was told that great quantities of trout and other fishes run out into the irrigating ditches and are left to die as the water spreads over the fields. Unless these ditches are screened or some effective means taken to prevent fish from entering them, it will not be many years before the trout of the Upper Rio Grande will be a thing of the past. Suckers and all other species that are more or less migratory will also be seriously affected by the present irrigation methods.

In Chihuahua and the other Mexican states lying along the Rio Grande, and to some extent in the Llano Estacado and the Trans-Pecos region, are found some small isolated bodies of water which have at present no outlet to the sea; most notable among these is Lake Guzman in the northern part of Chihuahua, into which flow the Rio Mimbres and Rio Janos. While these lakes and sinks have at present no connection with the Rio Grande, they probably all did have at one time and properly belong to the basin of that river.

Summing up the climatic and hydrographic features of Texas and the Rio Grande basin, the conditions which are most characteristic and which are most important in their bearing upon the fish life of that vast territory, are the following: The distribution of rainfall throughout the year is very irregular, resulting in periods of heavy rains and long seasons of drought; this results in periodic freshets which suddenly swell the streams to enormous proportions, to be followed by seasons of little rain when these great rivers dwindle to mere creeks, isolated stagnant pools, or in some cases to dry arroyos. The soil and surface rock over extensive areas contain gypsum, salt, and other easily soluble minerals. As a result of this and the ease with which the surface is eroded, the waters of many of the streams are always more or less alkaline, and after heavy rains are heavily laden with solid matter in suspension. These freshets, laden with the rich, red loam of the plains, usually reach the lower inhabited sections of the plains during their seasons of drought, and are called "red rises."

HISTORICAL AND BIBLIOGRAPHICAL.

So far as we have been able to learn, the first collections of fishes in this region for scientific purposes were made by John H. Clark, in 1851. This was under Col. J. D. Graham, of the United States and Mexican Boundary Commission. The streams in which collections were made by this party in 1851 are chiefly of the Nueces and Rio Grande basins. This was followed by the various other parties of the Mexican Boundary Survey, the Pacific Railroad Surveys, and by Captains Marcy and McClellan's Red River expedition, all of which explorations were completed prior to 1858. Each of these expeditions had attached to it one or more persons who officiated as naturalists, each of whom is named in this paper in connection with the consideration of the respective collections. Considering the disadvantages under which they labored, the collections obtained, especially by Mr. John H. Clark, Dr. C. B. R. Kennerly, Dr. George C. Shumard, and Lieut. Couch, are remarkable for their completeness.

The first of these collections was studied and reported upon by Prof. Spencer F. Baird and Dr. Charles Girard, while the later ones were reported upon by Dr. Girard alone. The preliminary reports appeared at intervals from 1853 to 1858, in the proceedings of the Philadelphia Academy of Sciences, the final reports appearing in the Zoölogy of the Mexican Boundary and Pacific Railroad surveys.

The next collection of fishes made in this region was that obtained in Colorado by the Hayden Survey in 1872. These were studied by Prof. Cope, whose report was published in Hayden's fifth annual report.

The various parties of the Wheeler Survey west of the one hundredth meridian made extensive collections of fishes in the upper Rio Grande Basin. These were reported upon by Prof. E. D. Cope and Dr. H. C. Yarrow.

In 1878 Dr. Jordan published a paper on a collection made at Brownsville.

In 1880, in his important paper on the "Zoölogical Position of Texas," Prof. Cope gives notes on 24 species of fishes, chiefly from the basins of the Trinity, Red, and Colorado rivers. Seven of these were described as new.

In 1881 Prof. Samuel Garman published a short paper on 14 species of the Rio Grande basin, 8 of which were regarded by him as new. These specimens are contained in the collections of the Museum of Comparative Zoölogy, but it is not stated by Prof. Garman by whom they were collected.

No collecting of the salt-water fishes of the Texas coast after the time of the Mexican Boundary surveys was done until 1882, when Dr. Jordan obtained about 50 species at Galveston. This was the first considerable collection made on the Texas coast.

Important collections were made in 1884 by Dr. Jordan and Prof. C. H. Gilbert, who obtained over 50 species, many of which were new to the State and 4 new to science. This was the largest collection of fresh-water fishes ever made in Texas up to that time.

In the summer of 1889, during Dr. Jordan's explorations in Colorado and Utah, some collecting was done in the Rio Grande basin near Del Norte and Alamosa, Colo. Only 4 species, however, were obtained.

In the summer of 1890, Mr. Orland Coate, at that time one of Prof. Evermann's students in the Indiana State Normal School, spent some time in the Panhandle of Texas, where he made a small but important collection. This collection embraced 11 species and was made in Fulton and Spring creeks near Creswell. No fishes had ever been collected in that part of the State, and none in the upper Canadian since the time of the exploration of the Red River by Captains Marcy and McClellan.

As stated elsewhere in this paper, Prof. Evermann made collections of Texan fishes in 1891, chiefly about Galveston and Corpus Christi on the coast, and in the basins of the Neches, Trinity, and San Antonio rivers, and Buffalo Bayou. The total number of species obtained is 131, of which 67 are salt-water species and 64 are fresh-water forms. These are the most extensive collections ever made in Texas and add no fewer than 18 species to the known fresh-water fauna of the State. The number of new species is 11.

In the following pages are given the titles of the various papers which have dealt in any way with the fishes of Texas or the Rio Grande region. These titles have been arranged in chronological order, and under each is given a brief summary of the information which it contains.

1853*a*. SPENCER F. BAIRD and CHARLES GIRARD. Descriptions of New Species of Fishes collected by Mr. John H. Clark, on the United States and Mexican Boundary Survey, under Lt. Col. James D. Graham. Proc. Acad. Nat. Sci. Phila., August, 1853, 387-390.

This is the first paper in which were published any of the ichthyological results of the explorations carried on in connection with the United States and Mexican Boundary Survey and the Pacific Railroad surveys. This paper was followed by others from time to time, all of which were published in the Proceedings of the Philadelphia Academy, the final reports appearing later in the volumes of the respective surveys. In this particular paper 17 species are given, all of which were described as new. Of these 17 species, 11 were based upon specimens obtained in Texas, the other 6 having come from the basin of the Colorado of the West. As now understood, only 5 of these 11 nominal species are admitted as tenable species.

In the following table are given (1) the page upon which the species is mentioned in the publication referred to; (2) a list of the nominal species given by Baird and Girard in the above-named paper as having come from the region covered by the geographic limits of the present report; (3) the present identification of each of those nominal species as now understood by us, and (4) the locality from which the specimens were obtained. Names of new species and new genera are printed in italics. This method of treatment is followed in the case of the various other papers which are summarized in this report.

Page.	Nominal species.	Identification.	Locality.
387	Pileoma *carbonaria*	Etheostoma caprodes	Rio Salado.
388	Boleosoma *lepida*	Etheostoma lepidum	Upper tributaries of the Rio Nueces.
388	Pomotis *aquilensis*	Lepomis cyanellus	Eagle Pass.
389	Fundulus *grandis*	Fundulus heteroclitus grandis	Indianola.
389	Hydrargyra *similis*	Fundulus similis	Do.
389	Cyprinodon *elegans*	Cyprinodon elegans	Rio Grande.
389	Cyprinodon *bovinus*	Cyprinodon variegatus	Leon Springs, Rio Grande.
390	Cyprinodon *gibbosus*	do	Indianola.
390	Heterandria *affinis*	Gambusia affinis	Rio Medina and Rio Salado.
390	Heterandria *nobilis*	do	Leon and Comanche Springs.
390	Heterandria *patruelis*	do	Rio Sabinal, Rio Leona, Rio Nueces, and Elm Creek, all of the Nueces Basin.

1853*b*. SPENCER F. BAIRD and CHARLES GIRARD. Description of New Species of Fishes collected by Captains R. B. Marcy and Geo. B. McClellan, in Arkansas. Proc. Acad. Nat. Sci. Phila., August, 1853, 390–392.

Page.	Nominal species.	Identification.	Locality.
390	Pomotis *breviceps*	Lepomis megalotis	Otter Creek, Arkansas.
391	Pomotis *longulus*	Lepomis cyanellus	Do.
391	Leuciscus *lutrensis*	Notropis lutrensis	Do.
391	Leuciscus *bubalinus*	Notropis bubalinus	Do.
391	Ceratichthys *vigilax*	Cliola vigilax	Do.

1854*a*. S. F. BAIRD and C. GIRARD. Fishes [collected by Captains R. B. Marcy and Geo. B. McClellan in Arkansas]. Exploration of the Red River of Louisiana, in the year 1852; by Randolph Marcy, Captain, Fifth Infantry, U. S. Army; assisted by George B. McClellan, Brevet Captain, U. S. Engineers. With reports on the Natural History of the country and numerous illustrations. Fishes, pp. 216-223, plates XII–XIV. Washington, 1854.

This exploration of the Red River was made between April 30 and July 29, 1852. The party was accompanied by Dr. George C. Shumard, and it is, no doubt, to him that we owe the small collection of fishes which was made in Otter Creek, either on May 28–29 or July 12–14, the exact date being impossible to determine, as the party camped at the same place near the creek upon the return as well as upon the outward trip. This small collection was, apparently, made near their camp, which was situated about 4 miles above the union of Otter Creek with the North Fork of Red River, which is probably not more than 12 miles from the junction of the North and South Forks of Red River. Otter Creek, which was so named by Captain Marcy because of the abundance of otters there at that time, is described by him as a "fine, bold, running creek of good water, rising in the Wichita Mountains and running a course south 23° west. It is 50 feet wide and 1 foot deep at a low stage of water. The temperature of the water in the creek at our encampment we found to be 72° F." [in May]. It does not appear from Captain Marcy's report that any fishes were collected upon the expedition except those obtained in Otter Creek. This collection was a small one, consisting of but five species, all of which were regarded by Baird and Girard as new, and first described by them in the Proceedings of the Philadelphia Academy in 1853. This paper was reprinted, practically without change, in Captain Marcy's report, but with the addition of three plates illustrating each of the five species. From the table given under the preceding paper it may be seen that three of these nominal species are now accepted.

1854*b*. S. F. BAIRD and CHARLES GIRARD. Descriptions of New Species of Fishes collected in Texas, New Mexico, and Sonora, by Mr. John H. Clark, on the U. S. and Mexican Boundary Survey, and in Texas by Capt. Stewart Van Vliet, U. S. A. Proc. Acad. Nat. Sci. Phila., March, 1854, 24–29.

In a footnote it is stated that "the species described in this paper from the waters of western Texas and those emptying into the Gila, were collected while the Boundary Survey was in charge of Col. J. D. Graham; the others, while under Maj. W. H. Emory." In the following table is given a list of all the nominal species of that paper from Rio Grande and Texan localities, together with the present identification of each.

Page.	Nominal species.	Identification.	Locality.
24	Pomotis *speciosus*	Lepomis pallidus	Brownsville, Texas.
24	Pomotis *fallax*	Lepomis megalotis	Elm Creek, Texas.
24	Pomotis *convexifrons*	do	Rio Cibolo, Texas.
24	Pomotis *nefastus*	do	Rio Cibolo and Rio Salado.
25	Pomotis *heros*	Lepomis heros	Rio Cibolo, Texas.
25	Bryttus longulus	Lepomis cyanellus	Do.
25	Grystes *nuecensis*	Micropterus salmoides	Rio Nueces and Rio Frio.
25	Herichthys *cyanoguttatus*	Heros cyanoguttatus	Brownsville (fresh water).
26	*Ailurichthys* marinus	Felichthys marinus	Indianola, Texas.
26	Arius *equestris*	Tachysurus felis	Do.
26	Pimelodus *affinis*	Ictalurus furcatus	Rio Grande.
27	*Astyanax argentatus*	Tetragonopterus argentatus	Upper tributaries of Rio Nueces.
27	Catostomus *congestus*	Moxostoma congestum	Rio Salado, Texas.
28	Catostomus *plebeius*	Pantosteus plebeius	Rio Mimbres.
28	Carpiodes *tumidus*	Carpiodes velifer tumidus	Near Fort Brown, Texas.
29	Gila pulchella	Leuciscus nigrescens	Rio Mimbres.

1854*c*. S. F. BAIRD and CHARLES GIRARD. Notice of a new genus of *Cyprinidæ*. Proc. Acad. Nat. Sci. Phila. 1854, 158.

In this paper the genus *Cochlognathus* is established and the species *Cochlognathus ornatus* is first described. The specimens upon which the genus and species were based were collected by Capt. Van Vliet, at Brownsville, Tex.

1856*a*. CHARLES GIRARD, M. D. Researches upon the Cyprinoid Fishes inhabiting the fresh waters of the United States of America west of the Mississippi Valley, from specimens in the Museum of the Smithsonian Institution. Proc. Acad. Nat. Sci. Phila., September, 1856, 165–213.

This interesting, important, but somewhat troublesome paper also appeared in an author's edition with repagination, pp. 1–54, the last four pages being an "Alphabetical List of the [62] species collected by the United States and Mexican Boundary Commission, Maj. Wm. H. Emory, Commissioner," and an "Index to the Systematic Names not included in the foregoing List." This list contains, of course, only the *Cyprinidæ* and *Catostomidæ* of the Mexican Boundary Survey. As this paper contains the original descriptions of so many species from Texas and the Rio Grande basin, it seems proper to reprint a portion of that part referring to the various sources from which the collections were obtained. He says:

> The fishes which are the subject of the present memoir were collected at different times and periods by the several naturalists and surgeons attached to the various surveys undertaken within the five years past. And, first of all, there is the survey of the United States and Mexican boundary, from 1851 to 1855. John H. Clark, who accompanied Col. J. D. Graham in 1851, collected extensively in the rivers and creeks of Texas and New Mexico. Under Maj. W. H. Emory, now commissioner of the boundary line, numerous collections were made by Dr. C. B. R. Kennerly in Texas, in the valley of the Rio Grande and provinces of Chihuahua and Sonora.
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> The survey of routes for a railroad to the Pacific was commenced in 1853 and continued until 1855. Lieut. A. W. Whipple, under whose command the survey near the thirty-fifth parallel of latitude was effected, in securing the services of Dr. C. B. R. Kennerly contributed very largely to our collections of fishes from Texas and the numerous tributaries of the Arkansas River. H. B. Möllhausen, artist to the same expedition, showed also much zeal and industry for collecting. * * * The eastern end of the same thirty-second parallel was explored by Capt. John Pope, who, having attached to his party Dr. Geo. C. Shumard, interesting specimens were obtained therefrom. * * * Lieut. D. N. Couch, U. S. A., explored, in the winter of 1852–53, the Mexican provinces of Tamaulipas, New Leon, and Coahuila, thus adding materials towards an elucidation of the natural history of the country south of the Rio Grande del Norte (Rio Bravo), and but partially explored by the United States and Mexican Boundary Commission. * * * To John Potts, esq., of Chihuahua, we owe some very interesting species from the hydrographic basin of Chihuahua River and the valley of Mexico.

The total number of species given in this paper is 196, of which 66 are given as found in Texas or the basin of the Rio Grande. Of these 66 species, 56 are described as new, of which latter number only 30 are now recognized as good species.

Page.	Nominal species.	Identification.	Locality.
170	Ictiobus tumidus	Carpiodes velifer tumidus	Rio Grande.
171	Moxostoma *claviformis*	Erimyzon sucetta	Coal Creek.
171	Moxostoma *kennerlii*	do	Dry Creek, near Victoria.
171	Moxostoma *victoriæ*	Minytrema melanops	Do.
172	Moxostoma *campbelli*	Erimyzon sucetta	Live Oak Creek and Devil River.
172	Ptychostomus congestus	Moxostoma congestum	Rio Salado.
172	Ptychostomus *albidus*	do	Rio San Juan, near Monterey.
173	Minomus plebeius	Pantosteus plebeius	Rio Mimbres, Lake Guzman.
173	Catostomus (Acomus) *guzmaniensis*.	do	Janos River, Lake Guzman.
176	Campostoma *ornatum*	Campostoma ornatum	Chihuahua River.
176	Campostoma *formosulum*	Campostoma formosulum	Rio Sabinal, trib. San Antonio River.
176	Campostoma *nasutum*	Campostoma anomalum	Cadereita and near Monterey, New Leon.
177	Dionda *episcopa*	Dionda episcopa	Headwaters of Rio Pecos and Comanche Spring.
177	Dionda *serena*	Dionda serena	Rio Sabinal.
177	Dionda *texensis*	Dionda episcopa	Rio Nueces.
178	Dionda *papalis*	Dionda serena	Delaware Creek.
178	Dionda *argentosa*	Dionda episcopa	San Felipe Creek and Devil River.
178	Dionda *chrysitis*	Dionda serena	Live Oak Creek of Pecos River.
178	Dionda *melanops*	Dionda melanops	Buena Vista, Coahuila.
178	Dionda *couchi*	do	Coajuco, Monterey, and Cadereita, in waters of Rio San Juan, New Leon.
178	Dionda *plumbea*	Zophendum plumbeum	Headwaters of Canadian River.
179	Hyborhynchus *tenellus*	Pimephales notatus	20 miles west of Choctaw Agency.
179	Hyborhynchus *puniceus*	Zophendum plumbeum	Antelope Creek and Llano Estacado.
179	Hyborhynchus *confertus*	Pimephales promelas confertus	Hurrah Creek.
181	Algoma *amara*	Dionda amara	In a lagoon near Fort Brown.
181	Algoma *fluviatilis*	Dionda fluviatilis	Near Monterey, New Leon.
181	Cochlognathus ornatus	Cochlognathus ornatus	Brownsville.
189	Gobio *æstivalis*	Hybopsis æstivalis	Rio San Juan near Cadereita, New Leon.
190	Leucosomus *pallidus*	Semotilus atromaculatus	Antelope Creek, Arkansas.
190	Leucosomus *incrassatus*	do	20 miles west of Choctaw Agency.
192	Cliola vigilax	Cliola vigilax	Otter Creek, Arkansas.
192	Cliola *velox*	do	San Pedro Creek.
192	Cliola *vivax*	do	Leon River.
193	Alburnus *amabilis*	Notropis amabilis	Rio Leona.
193	Alburnus *megalops*	Notropis swaini	San Felipe Creek.
193	Alburnus *socius*	Notropis socius	Live Oak Creek of Pecos River.
195	Codoma *ornata*	Notropis ornatus	Chihuahua River and tributaries.
197	Cyprinella bubalina	Notropis bubalinus	Otter Creek, Arkansas.
197	Cyprinella *umbrosa*	do	Coal Creek, and 20 miles west of the Choctaw Agency.
197	Cyprinella *suavis*	Notropis lutrensis	Near San Antonio.
197	Cyprinella *lepida*	Notropis lepidus	Rio Frio.
198	Cyprinella *notata*	Notropis notatus	Do.
198	Cyprinella *macrostoma*	Notropis macrostomus	Devil River and at China, New Leon.
198	Cyprinella *venusta*	Notropis venustus	Rio Sabinal.
198	Cyprinella *texana*	Notropis texanus	Rio Salado and Turkey Creek.
198	Cyprinella *luxiloides*	Notropis macrostomus	San Pedro Creek.
199	Moniana lutrensis	Notropis lutrensis	Otter Creek, Arkansas, and Gypsum Creek.
199	Moniana *leonina*	Notropis leoninus	Leon River.
199	Moniana *deliciosa*	Notropis deliciosus	Do.
200	Moniana *proserpina*	Notropis proserpina	Devil River.
200	Moniana *aurata*	do	Piedra Painte.
200	Moniana *complanata*	Notropis leoninus	Brownsville.
200	Moniana lætabilis	Notropis lutrensis	Hurrah Creek.
200	Moniana *frigida*	Notropis leoninus	Rio Salado, Rio Sabinal, Rio Medina, and Rio Nueces.
201	Moniana *couchi*	Notropis lutrensis	China, New Leon.
201	Moniana *rutila*	do	Cadereita, New Leon.
201	Moniana *nitida*	Notropis nitidus	Do.
201	Moniana *formosa*	Notropis formosus	Rio Mimbres, Mexico.
201	Moniana *gracilis*	Notropis lutrensis	Monterey, New Leon.
201	Moniana *gibbosa*	do	Brownsville.
203	Luxilus *leptosomus*	Notemigonus chrysoleucus	Dry Creek, near Victoria.
203	Luxilus *seco*	do	Rio Seco.
203	Luxilus *lucidus*	Notropis umbratilis	Coal Creek, and 20 miles west of Choctaw Agency.
206	Tigoma pulchella	Leuciscus nigrescens	Rio Mimbres, Mexico.
207	Tigoma *nigrescens*	do	Boca Grande and Janos River, Mexico.
207	Tigoma *pulchra*	do	Chihuahua River and tributaries.

1857. Charles Girard, M. D. Notice upon New Genera and New Species of Marine and Fresh-water Fishes from western North America. Proc. Acad. Nat. Sci. Phila., November, 1857, 200-202.

In this paper Dr. Girard mentions six species of sunfishes from the region embraced within the scope of the present article, all of which he describes as new. It is not stated when or by whom these fishes were collected, but it is quite certain they form part of the collections of the various Pacific Railroad and Mexican Boundary expeditions. Only one of the six is now regarded as a good species.

Page.	Nominal species.	Identification.	Locality.
200	Calliurus *melanops*	Chænobryttus gulosus	Fresh waters of Texas.
200	Calliurus *diaphanus*	Lepomis cyanellus	Rio Blanco, Texas.
200	Calliurus *microps*	do	Do.
200	Calliurus *murinus*	do	From Texas.
200	Bryttus *albulus*	Lepomis albulus	Rio Blanco, Texas.
201	Bryttus *signifer*	Lepomis cyanellus	Rio Medina.

1858. Charles Girard. Reports upon the Fishes collected by the various Pacific Railroad Explorations and Surveys. Vol. VI, Part IV, No. 1, 9-34; Vol. X, Part IV, No. 4, 21-27; Vol. X, Part IV, 1-400; Vol. X, Part IV, No. 4, 83-91; and Vol. X, Part IV, No. 5, 47-59; numerous plates.

Of the Pacific Railroad Reports, vol. X, part 4, contains the reports upon the collections made in Texas and the upper Rio Grande basin. The various exploring expeditions which were sent out by the United States Government in connection with the Pacific Railroad surveys and the United States and Mexican Boundary survey, gave to us our first knowledge of the ichthyology of the southwestern United States and of Mexico. Of the different parties engaged on these surveys, collections of fishes were made within the present limits of the State of Texas or within the hydrographic basin of the Rio Grande by the parties under Capt. John Pope and Lieut. A. W. Whipple. Capt. Pope's party was engaged in the "Exploration of a Route for a Pacific Railroad, near the thirty-second parallel, from the Red River to the Rio Grande." The fishes, reptiles, and insects obtained on this expedition were collected chiefly by Dr. George C. Shumard and Lieut. L. H. Marshall. This party arrived at Doña Ana, on the Rio Grande, from Albuquerque, New Mexico, January 16, 1854, and on February 12 started eastward toward Red River. They reached the mouth of Delaware Creek at the falls of the Pecos March 8, and reported the waters of the Pecos as being discolored and abounding in catfish of a very large size. Lieut. Marshall went up the Pecos about 40 miles to the mouth of the Sacramento River, which he states was about 50 feet wide and 6 feet deep. He found catfish and suckers of a large size, and says that trout are caught higher up the Sacramento. The next stream of importance which is mentioned is the most eastern branch of the Colorado, which they crossed April 16. Here the "stream is deep; the water is beautifully clear and fresh, and there is an abundance of fish—trout, buffalo, catfish, sunfish, perch, and bass, of which we caught a great many."

On April 17 they came upon a stream of running water, a tributary of the Brazos, which contained "an abundance of trout, bass, sunfish, and catfish," some of which they caught. This must have been the stream called Double Mountain Fork on Capt. Pope's map. On April 21 they caught fish in a pond still further east and camped that night upon the Brazos, in which they found "catfish, sunfish, buffalo, trout, gar, etc., abundant." The water was pure and clear, and the bottom firm. This stream, which is the Clear Fork of the Brazos, was found by Capt. Pope to be a large stream, heavily timbered, about 25 yards wide, and very deep; the water was excellent and abounded in fish. They collected a good many fish here, among them a "gar-fish," which they had not before seen. They described it as being "of a bright yellow color, and enveloped in a hard, scaly covering, more like shell than cuticle. It has a long pointed head, armed with a numerous and formidable set of teeth, well adapted for seizing and holding its prey"—probably the short-nosed gar, ***Lepisosteus platystomus***. From there the route led across the Brazos at Fort Belknap, then the West Fork of the Trinity, Turkey Creek, a tributary of the Red, and Elm Fork of the Trinity, which was described as being clear and pure and very deep in some places, with plenty of perch, bass, sunfish, etc. The expedition arrived at Preston, on the Red River, May 15, 1854, the distance traveled having been about 640 miles.

The party under Lieut. Whipple made the "Exploration for a railway route, near the thirty-fifth parallel, from the Mississippi to the Pacific Ocean." Attached to Lieut. Whipple's party were Dr. C. B. R. Kennerly as physician and naturalist, Dr. J. M. Bigelow as surgeon and botanist, and Mr. H. B. Möllhausen as topographer and artist; and the collections of fishes obtained are due to the labors of these gentlemen. The party began its work at Fort Smith on the Arkansas River, July 14, 1853, from which they traveled westward, following closely the course of the Canadian River. On August 13 they camped upon a small branch of Coal Creek, which they describe as being "obstructed by ledges of rock, producing long and deep reservoirs of crystal water, abounding in fish." On August 29 the party passed "Rock Mary, on the south bank of the South Fork of Canadian River, where some fishing was done." On August 31 they "entered a pretty little valley watered by a rivulet, with pools abounding in fishes supposed to be of unknown species. We call the stream Gypsum Creek, from being the first of importance in that formation. It is finely wooded with red oak, post oak, alamo, and elm. The water is tinctured with magnesia, and is disagreeable to the taste. The channel is deep, leaving, at the present low water, high steep banks difficult to pass." A few miles west of this a small stream was crossed which received the name Elm Creek and from which some fishes were obtained. From here Lieut. Whipple continued to follow up the South Fork of the Canadian. The divide between the headwaters of the Canadian and those of the Pecos was crossed September 24, and on September 26 they crossed Hurrah Creek, where some fishes were collected. In this creek, which is a tributary of the Gallinas, the water stood simply in holes. About 15 miles more, and the "Rio de Gallinas, a creek of pure running water, but with neither wood nor grass upon its banks," was reached. The Gallinas Creek is a branch of the Rio Pecos, which was reached at Anton Chico on the same day; and nine days later the party arrived at Albuquerque, on the Rio Grande.

The total number of species mentioned in the Pacific Railroad Reports as found within the limits of the region covered by this paper is 49, of which 8 are described as new. Most of the other 41 had already been described as new in the Proceedings of the Philadelphia Academy.

The following table contains a list of these 49 species together with the localities from which they were obtained, the collector, and the present identification of each:

Table showing the species of fishes found in Texas and the Rio Grande Basin by the various Pacific Railroad survey expeditions.

Page.	Nominal species.	Identification.	Locality.	Collector.
4	Dioplites nuecensis	Micropterus salmoides	Blanco, Frio, Leon, Seco, and Medina rivers.	Dr. Kennerly.
			Coal Creek, Arkansas	H. B. Möllhausen.
			Brazos River	Dr. G. C. Shumard.
			Delaware Creek	Capt. Pope.
			Frio, Nueces, and Leona rivers, and Live Oak, Turkey, and Elm creeks.	John H. Clark.
			San Juan River, New Leon	Lieut. Couch.
			Sabinal and Minnevilla rivers, and Dry and San Pedro creeks.	Dr. Kennerly.
11	Calliurus melanops	Lepomis cyanellus	Leon and Medina rivers, and Dry and San Pedro creeks.	Do.
13	Calliurus diaphanus	do	Rio Blanco	Do.
14	Calliurus formosus	do	Tributary of Gypsum Creek	H. B. Möllhausen.
			Headwaters of Brazos and Colorado rivers, and Red River at Fort Washita.	Capt. Pope.
			Brazos River	Dr. Shumard.
16	Calliurus longulus	do	Otter Creek, Arkansas	Capt. R. B. Marcy.
			Rio Cibolo	John H. Clark.
			Mineville, Texas, and Rio Seco	Dr. Kennerly.
			Pecos River	Capt. Pope.
17	Calliurus micropa	do	Red River at Fort Washita	Do.
			Brazos River	Dr. Shumard.
18	Calliurus murinus	do	Delaware Creek and headwaters of Brazos River.	Capt. Pope.
19	Bryttus albulus	Lepomis albulus.	Brazos River	Dr. Kennerly.
20	Bryttus signifer	Lepomis cyanellus	Medina River	Do.
21	Bryttus humilis	Lepomis humilis	Near Rock Mary	H. B. Möllhausen.
			Brazos River	Dr. Shumard.
23	Pomotis speciosus	Lepomis pallidus	Brownsville	Capt. Van Vliet.
			Near Indianola	Capt. Pope.
			Devil, Medina, and Seco rivers	Dr. Kennerly.
			Cadereita, New Leon	Lieut. Couch.
			New Braunfels	Dr. Lindheimer.
24	Pomotis heros	Lepomis heros	Blanco River and Dry Creek, near Victoria.	Dr. Kennerly.
			Cibolo River	John H. Clark.
			Nueces River	Capt. Pope.
			San Juan River near Cadereita	Lieut. Couch.
			Fort Bliss, N. Mex	Dr. S. W. Crawford.
25	Pomotis aquilensis	Lepomis cyanellus	Eagle Pass	A. Schott.
			San Felipe Creek, Rio Cibolo, and Rio Nueces.	John H. Clark.
			Rio Sabinal, San Pedro Creek near San Antonio, Leon and Blanco rivers.	Dr. Kennerly.
			Nueces River	Capt. Pope.
26	Pomotis *popeii*	Lepomis megalotis	Headwaters of Colorado River	Do.
27	Pomotis fallax	do	Comanche Spring	Dr. A. L. Hermann.
			Sans Bois Creek and tributary of Gypsum Creek.	H. B. Möllhausen.
			Seco and Medina rivers and Live Oak and San Pedro creeks.	Dr. Kennerly.
			Cibolo and Salado rivers and Elm Creek.	John H. Clark.
			Delaware Creek	Capt. Pope.
28	Pomotis breviceps	do	Headwaters of Colorado and Brazos rivers, and tributaries of Red River at Fort Washita.	Do.
			Otter Creek, Arkansas	Capt. Marcy.
			Brazos River	Dr. Shumard.
209	Pimelodus *felinus*	Ameiurus natalis	Tributary Gypsum Creek, and Coal Creek, Arkansas.	H. B. Möllhausen.
209	Pimelodus *antoniensis*	do	Near San Antonio	Dr. Kennerly.
211	Pimelodus *lupus*	Ameiurus lupus	From Indianola to Nueces, and headwaters of Rio Pecos.	Capt. Pope.
219	Moxostoma claviformis	Erimyzon sucetta	Coal Creek, Arkansas	H. B. Möllhausen.
227	Dionda episcopa	Dionda episcopa	Headwaters of Rio Pecos	Capt. Pope.
228	Dionda papalis	Dionda serena	Delaware Creek	Do.
228	Dionda plumbea	Zophendum plumbeum	Headwaters of Canadian River (Llano Estacado).	H. B. Möllhausen.
230	Dionda *grisea*	do	20 miles west of Choctaw Agency	Do.
231	Hyborhynchus tenellus	Pimephales notatus	do	Do.
232	Hyborhynchus puniceus.	Zophendum plumbeum	Llano Estacado and Antelope Creek	H. B. Möllhausen and Dr. Kennerly.
233	Hyborhynchus confertus	Pimephales promelas confertus.	Hurrah Creek	H. B. Möllhausen.

Table showing the species of fishes found in Texas and the Rio Grande Basin by the various Pacific Railroad survey expeditions—Continued.

Page.	Nominal species.	Identification.	Locality.	Collector.
251	Leucosomus pallidus	Semotilus atromaculatus.	Antelope Creek, Arkansas	Dr. Kennerly.
252	Leucosomus incrassatus	do	20 miles west of Choctaw Agency	H.B. Möllhausen.
257	Cliola vigilax	Cliola vigilax	Otter Creek, Arkansas	Capt. Geo. B. McClellan.
258	Cliola velox	do	San Pedro Creek	Dr. Kennerly.
258	Cliola vivax	do	Leon River	Do.
259	Alburnellus dilectus	Notropis dilectus	Arkansas River, Fort Smith	Dr. Shumard.
265	Cyprinella bubalina	Notropis bubalinus	Otter Creek, Arkansas	Capt. McClellan.
266	Cyprinella umbrosa	do	Coal Creek, and 20 miles west of Choctaw Agency.	H. B. Möllhausen.
268	Cyprinella suavis	Notropis lutrensis	Near San Antonio	Dr. Kennerly.
268	Cyprinella lepida	Notropis lepidus	Rio Frio	Do.
269	Cyprinella notata	Notropis notatus	Rio Seco	Do.
272	Moniana lutrensis	Notropis lutrensis	Otter Creek and tributaries of Gypsum Creek, Arkansas.	Capt. McClellan and H. B. Möllhausen.
273	Moniana leonina	Notropis leoninus	Leon River	Dr. Kennerly.
274	Moniana deliciosa	Notropis deliciosus	do	Do.
275	Moniana lætabilis	Notropis lutrensis	Hurrah Creek	H. B. Möllhausen.
276	Moniana frigida	Notropis leoninus	Rio Frio	Dr. Kennerly.
281	Luxilus seco	Notemigonus chrysoleucus.	Rio Seco	Do.
282	Luxilus lucidus	Notropis umbratilis	Coal Creek, and 20 miles west of Choctaw Agency.	H. B. Möllhausen.
320	Salar virginalis	Salmo mykiss spilurus	Utah Creek, tributary of Rio Grande	Mr. Kreuzfeld.
351	Lepidosteus *leptorhynchus*.	Lepisosteus tristœchus.	Devil River	Dr. Shumard.
352	Lepidosteus (Cylindrosteus) *latirostris*.	Lepisosteus platystomus.	Pecos River	Capt. Pope.
353	Lepidosteus (Atractosteus) *berlandieri*.	Lepisosteus tristœchus.	Tamaulipas, Mexico	L. Berlandier.

1859*a*. CHARLES GIRARD. Ichthyology of the Boundary. <Report of the United States and Mexican Boundary Survey, made under the direction of the Secretary of the Interior, by William H. Emory, Major, First Cavalry, and United States Commissioner. Vol. 3, Washington, 1858, pp. 1–85, plates 1–40.

In this final report upon the Ichthyology of the Mexican Boundary Survey, Girard mentions 111 species as having been obtained in Texas and the Rio Grande basin, 25 of which he describes as new. Of the remaining 86 species, 2 species were described by Baird and Girard in the 9th Smithsonian Report, 12 in the Proceedings of the Philadelphia Academy for 1853, 14 in the same for 1854, and 39 by Girard in his Researches upon the Cyprinoid Fishes, published in the same Proceedings for 1856. Of the 25 species first described in the paper now under consideration, 9 have stood the test of further exploration and investigation and are still regarded as good species.

Texas and Rio Grande Basin fishes of the Mexican Boundary survey.

Page.	Nominal species.	Identification.	Locality.	Collector.
3	Dioplites nuecensis	Micropterus salmoides	Frio, Nueces, and Leona rivers, and Live Oak, Turkey, and Elm creeks.	Col. J. D. Graham.
			San Juan River, New Leon	Lieut. D. N. Couch.
			Sabinal and Minneville rivers, and Dry and San Pedro creeks.	Maj. Emory.
5	Calliurus longulus	Lepomis cyanellus	Cibolo and Minneville rivers	Col. Graham and Maj. Emory.
5	Pomotis speciosus	Lepomis pallidus	Brownsville	Capt. Van Vliet.
			Devil River	Dr. Kennerly.
			Cadereita, New Leon	Lieut. Couch.
6	Pomotis heros	Lepomis heros	Cibolo River	Jno. H. Clark.
			Dry Creek, near Victoria	Dr. Kennerly.
			Rio San Juan, near Cadereita	Lieut. Couch.
7	Pomotis aquilensis	Lepomis megalotis	Eagle Pass	A. Schott.
			San Felipe, Rio Cibolo, and Rio Nueces	Jno. H. Clark.
			Sabinal River	Dr. Kennerly.

Texas and Rio Grande Basin fishes of the Mexican Boundary survey—Continued.

Page.	Nominal species.	Identification.	Locality.	Collector.
8	Pomotis fallax	Lepomis megalotis	Cibolo and Salado rivers and Elm Creek.	Jno. H. Clark.
			Live Oak and San Pedro creeks	Dr. Kennerly.
10	Pileoma carbonaria	Etheostoma caprodes	Salado and Medina rivers	Jno. H. Clark.
			San Pedro Creek	Dr. Kennerly.
11	Pœcilichthys lepidus	Etheostoma lepidum	Leona River	Jno. H. Clark.
11	Batrachus tau	Batrachus tau	Indianola	Do.
11	Otolithus nothus	Cynoscion nothus	Brazos Santiago	Lieut. Couch.
11	Leiostomus obliquus	Leiostomus xanthurus	do	G. Würdemann.
			Indianola	Jno. H. Clark.
11	Homoprion lanceolatus	do	St. Joseph Island	G. Würdemann.
11	Homoprion xanthurus	do	Brazos	Jno. H. Clark.
			St. Joseph Island	G. Würdemann.
11	Conodon antillanus	Rhomboplites aurorubens.	Brazos Santiago	Do.
11	Pogonias fasciatus	Pogonias chromis	do	Do.
11	Sargus ovis	Archosargus probatocephalus.	Indianola and Brazos	Jno. H Clark.
			Indianola	Dr. Kennerly.
			Brazos	G. Würdemann.
12	Otolithus drummondi	Cynoscion nebulosus	Indianola	Jno. H. Clark.
			Brazos	Dr. Kennerly.
			Brazos Santiago	G. Würdemann.
12	Amblodon *neglectus*	Aplodinotus grunniens.	Mouth of Rio Grande	Jno. H. Clark.
			Matamoras, Tamaulipas	L. Berlandier.
13	Umbrina *phalæna*	Menticirrhus americanus	Indianola	Jno. H. Clark.
			Brazos Santiago	G. Würdemann.
13	Micropogon undulatus	Micropogon undulatus	Mouth of Rio Grande	Jno. H. Clark.
			Indianola and Galveston	Dr. Kennerly.
			St. Joseph Island	G. Würdemann.
14	Johnius ocellatus	Sciæna ocellata	Indianola	Clark; Kennerly.
15	Orthopristis *duplex*	Orthopristis chrysopterus.	do	Jno. H. Clark.
			Brazos Santiago	G. Würdemann.
16	Lagodon rhomboides	Lagodon rhomboides	Brazos and Indianola	Jno. H. Clark.
			St. Joseph Island and Brazos Santiago.	G. Würdemann.
17	Eucinostomus argenteus.	Gerres gula	Brazos Santiago and St. Joseph Island.	Do.
			Brazos and Indianola	Clark; Kennerly.
18	Neonæmis emarginatus.	Lutjanus caxis	Brazos Santiago	G. Würdemann.
			Mouth of Rio Grande	Jno. H. Clark.
19	Polynemus *octonemus*	Polynemus octonemus	Brazos Santiago	G. Würdemann.
			Galveston	Dr. Kennerly.
20	Mugil *berlandieri*	Mugil cephalus	St. Joseph Island and Brazos Santiago.	G. Würdemann.
			Indianola and Brazos	Jno. H. Clark.
			Galveston	Dr. Kennerly.
21	Chorinemus *lanceolatus*.	Oligoplites saurus	St. Joseph Island	G. Würdemann
21	Chloroscombrus *caribbæus*.	Chloroscombrus chrysurus.	do	Do.
22	Doliodon carolinus	Trachynotus carolinus	do	Do.
23	Carangus *esculentus*	Caranx hippos	Brazos Santiago	Do.
			Mouth of Rio Grande	Jno. H. Clark.
23	Argyreiosus capillaris	Selene vomer	Matamoras	L. Berlandier.
24	Vomer setapinnis	Vomer setipinnis	Brazos Santiago	G. Würdemann.
24	Trichiurus lepturus	Trichiurus lepturus	St. Joseph Island	Do.
25	Gobionellus *hastatus*	Gobionellus oceanicus	do	Do.
25	Gobius *lyricus*	Gobius lyricus	Brazos Santiago	Do.
25	Gobius *würdemanni*	Gobius würdemanni	do	Do.
26	Gobius *catulus*	Gobius soporator	St. Joseph Island	Do.
26	Gobius *gulosus*	Lepidogobius gulosus	Indianola	Jno. H. Clark.
27	Gobiosoma *molestum*	Gobiosoma molestum	do	Do.
27	Blennius *multifilis*	Hypleurochilus geminatus.	St. Joseph Island	G. Würdemann.
28	Eleotris *sumnulentus*	Dormitator maculatus	Mouth of Rio Grande	Jno. H. Clark.
28	Eleotris gyrinus	do	do	Do.
29	Philipnus dormitator	Gobiomorus dormitator.	do	Do.
29	Ophidion *josephi*	Ophidion marginatum	St. Joseph Island	G. Würdemann.
30	Belone *scrutator*	Tylosurus longirostris	Brazos	Jno. H. Clark.
			St. Joseph Island	G. Würdemann.
30	Herichthys cyanoguttatus.	Heros cyanoguttatus	Devil River and lagoon at Fort Brown.	Jno. H. Clark.
			Brownsville	Capt. Van Vliet.
			Matamoras	L. Berlandier.
			Cadereita and San Juan River, New Leon.	Lieut. Couch.
31	Ailurichthys marinus	Felichthys marinus	Indianola	Jno. H. Clark.
32	Arius equestris	Tachysurus felis	do	Do.
32	Pimelodus affinis	Ictalurus furcatus	Mouth of Rio Grande	Do.
			Brownsville	Capt. Van Vliet.
33	Pimelodus *vulpes*	Ictalurus punctatus	Live Oak Creek	Dr. Kennerly.
			Comanche Spring, Rio Leona, Piedra Painte, Rio Salado, and Devil River.	Jno. H. Clark.
34	Ictiobus tumidus	Carpiodes velifer tumidus	Near Fort Brown	Do.
34	Moxostoma kennerlii	Erimyzon sucetta	Dry Creek, near Victoria	Dr. Kennerly.
35	Moxostoma victoriæ	Minytrema melanops	do	Do.
35	Moxostoma campbelli	Erimyzon sucetta	Devil River	Jno. H. Clark.
			Live Oak Creek	A. H. Campbell.

Texas and Rio Grande Basin fishes of the Mexican Boundary survey—Continued.

Page.	Nominal species.	Identification.	Locality.	Collector.
36	Ptychostomus congestus	Moxostoma congestum	Salado River	Jno. H. Clark.
36	Ptychostomus albidus	......do	Rio San Juan, near Monterey	Lieut. Couch.
38	Minomus plebeius	Pantosteus plebeius	Rio Mimbres	Jno. H. Clark.
39	Acomus guzmaniensis	......do	Janos River	Dr. Kennerly.
41	Campostoma ornatum	Campostoma ornatum	Chihuahua River and tributaries	Jno. Potts.
41	Campostoma formosulum	Compostoma formosulum	Sabinal River	Dr. Kennerly.
42	Campostoma nasutum	Campostoma anomalum	Cadereita and Acapulco, New Leon	Lieut. Couch.
42	Dionda serena	Dionda serena	Sabinal River	Dr. Kennerly.
42	Dionda texensis	Dionda episcopa	Nueces River	Jno. H. Clark.
43	Dionda argentosa	......do	San Felipe Creek and Devil River	Do.
44	Dionda chrysitis	Dionda serena	Live Oak Creek	Do.
44	Dionda melanops	Dionda melanops	Buena Vista, Coahuila	Lieut. Couch.
44	Dionda couchi	......do	Cuajuco, Monterey, and Cadereita, New Leon.	Do.
45	Algoma amara	Dionda amara	Lagoon, near Fort Brown	Jno. H. Clark.
45	Algoma fluviatilis	Dionda fluviatilis	Near Monterey	Lieut. Couch.
46	Cochlognathus ornatus	Cochlognathus ornatus	Brownsville	Capt. Van Vliet.
49	Gobio æstivalis	Hybopsis æstivalis	Rio San Juan, near Cadereita	Lieut. Couch.
51	Cliola velox	Cliola vigilax	San Pedro Creek	Dr. Kennerly.
51	Alburnellus amabilis	Notropis amabilis	Leona River	Jno. H. Clark.
52	Alburnellus megalops	Notropis swaini	San Felipe Creek	Do.
52	Alburnellus socius	Notropis socius	Live Oak Creek	Do.
53	Codoma ornata	Notropis ornatus	Chihuahua River and tributaries	Jno. Potts.
54	Cyprinella macrostoma	Notropis macrostomus	Devil River	Jno. H. Clark.
			China, New Leon	Lieut. Couch.
54	Cyprinella vennata	Notropis venustus	Sabinal River	Dr. Kennerly.
55	Cyprinella texana	Notropis texanus	Salado River and Turkey Creek	Jno. H. Clark.
55	Cyprinella luxiloides	Notropis macrostomus	San Pedro Creek	Dr. Kennerly.
56	Moniana aurata	Notropis proserpina	Piedra Painte, N. Mex	Jno. H. Clark.
56	Moniana complanata	Notropis leoninus	Brownsville	Capt. Van Vliet.
56	Moniana frigida	......do	Salado, Sabinal, and Medina rivers	Jno. H. Clark.
57	Moniana couchi	Notropis lutrensis	China, New Leon	Lieut. Couch.
57	Moniana rutila	......do	Cadereita, New Leon	Do.
58	Moniana nitida	Notropis nitidus	......do	Do.
58	Moniana formosa	Notropis formosus	Rio Mimbres	Dr. Kennerly.
59	Moniana gracilis	Notropis lutrensis	Acapulco, near Monterey, New Leon	Lieut. Couch.
59	Moniana gibbosa	......do	Brownsville	Capt. Van Vliet.
59	Moniana proserpina	Notropis proserpina	Devil River	Jno. H. Clark.
60	Luxilus leptosomus	Notemigonus chrysoleucus.	Dry Creek, near Victoria	Dr. Kennerly.
62	Tigoma pulchella	Leuciscus nigrescens	Rio Mimbres	Jno. H. Clark.
64	Tigoma nigrescens	......do	Boca Grande and Janos River	Dr. Kennerly.
65	Tigoma pulchra	......do	Chihuahua River and tributaries	Jno. Potts.
65	Cyprinodon elegans	Cyprinodon elegans	Comanche Springs	Jno. H. Clark.
67	Cyprinodon gibbosus	Cyprinodon variegatus	Indianola	Do.
67	Cyprinodon bovinus	......do	Leon Spring	Do.
68	Hydrargyra similis	Fundulus similis	Indianola	Do.
69	Fundulus grandis	Fundulus heteroclitus grandis.	......do	Do.
70	Pœcilia *lineolata*	Mollienesia latipinna	Brownsville	Capt. Van Vliet.
			Fort Brown	Jno. H. Clark.
70	Limnia *pœciloides*	......do	Indianola	Do.
71	Limnia *venusta*	Lucania venusta	......do	Do.
71	Gambusia nobilis	Gambusia affinis	Leon Spring, Comanche Spring, and Zoquito.	Do.
72	Gambusia affinis	......do	Medina and Salado rivers	Do.
72	Gambusia patruelis	......do	Salado, Leona, and Nueces rivers, and Elm and Turkey creeks.	Do.
74	Astyanax argentatus	Tetragonopterus argentatus.	Nueces, Leona, and Devil rivers, Zoquito, Comanche Springs, Elm, Turkey, and San Felipe creeks.	Col. J. D. Graham.
			Brownsville	Capt. Van. Vliet.
			Mouth of Rio Grande and Sabinal River.	Maj. Emory.
75	Saurus mexicanus	Synodus fœtens	Coast of Texas	G. Würdemann.
75	Anguilla *tyrannus*	Anguilla chrysypa	Mouth of Rio Grande	Maj. Emory.
			Matamoras	Lieut. Couch.
76	Neomuræna *nigromarginata*.	Gymnothorax ocellatus nigromarginatus.	St. Joseph Island	G. Würdemann.
77	Neoconger *mucronatus*	Neoconger mucronatus	......do	Do.

1859*b*. CHARLES GIRARD, M. D., Ichthyological Notices, Nos. I–LXXVII. < Proc. Acad. Nat. Sci., Phila. 1859.

This is a series of brief notes or papers upon fishes from various regions. Notices 10, 30 to 36 inclusive, 39, 42 to 50 inclusive, 54 to 59 inclusive, and 62 refer to Texas and Rio Grande fishes. Twenty-six species are mentioned, of which 19 are described as new. Six of these are still allowed to stand, though the proper identification of some of them is doubtful.

Page.	Nominal species.	Identification.	Locality.	Collector.
61	Hydrargyra *zebra*	Fundulus zebrinus	Between Fort Defiance and Fort Union, N. Mex.	Lieut. C. J. Ives.
101	*Alvarius lateralis*	Etheostoma lateralis	Mouth of Rio Grande	Boundary survey.
101	Diplesion *fasciatus*	Etheostoma fasciatus?	Chihuahua River	John Potts.
102	Aplesion *potsii*	Etheostoma lepidum	Chihuahua River and tributaries	Do.
102	Oligocephalus *leonensis*	do	Leona River	Jno. H. Clark.
102	Oligocephalus *grahami*	do	Devil River	Do.
102	Oligocephalus *pulchellus*	do	Gypsum Creek	Lieut. Whipple.
103	Boleosoma *gracile*	Etheostoma fusiforme	Seco River and Leona River near Fort Inge.	Dr. Kennerly.
103	Boleichthys *whipplei*	Etheostoma whipplei	Coal Creek, Ark	Lieut. Whipple.
104	Boleichthys *elegans*	Etheostoma fusiforme	Piedra Painte	Jno. H. Clark.
114	Mollinesia latipinna	Mollienesia latipinna	Galveston	Dr. Kennerly.
114	Mollinesia lineolata	do	Brownsville	
115	Limia pœciloides	do	Indianola	Jno. H. Clark.
115	Limia *formosa*	do	Lagoon at Palo Alto, Mexico	Do.
116	Limia *couchiana*	Pœcilia couchiana	Rio San Juan, Cadereita, New Leon	
117	Limia *matamorensis*	Mollienesia latipinna	Matamoras	L. Berlandier.
118	*Adinia multifasciata*	Adinia multifasciata	Galveston	Dr. Kennerly.
			St. Joseph Island	G. Würdemann.
			Indianola	Jno. H. Clark.
118	*Lucania* venusta	Lucania venusta	do	Do.
118	Lucania *affinis*	do	Matamoras	L. Berlandier.
120	Gambusia nobilis	Gambusia affinis	Comanche Spring	Lieut. J. G. Parke.
120	Gambusia affinis	do	San Pedro Creek and Dry Creek, near Victoria.	Dr. Kennerly.
121	Gambusia patruelis	do	Upper affluents of the Nueces River; Leona, Blanco, and Seco rivers	Do.
121	Gambusia *speciosa*	do	Rio San Diego, near Cadereita, New Leon.	D. N. Couch.
121	Gambusia *gracilis*	do	Matamoras	Louis Berlandier.
122	Gambusia *senilis*	do	Chihuahua River	John Potts.
158	Cyprinodon *eximius*		do	Do.

1872*a*. EDWARD D. COPE, A. M. Report upon the Recent Reptiles and Fishes of the Survey, collected by Campbell Carrington and C. M. Dawes. Prelim. Report U. S. Geol. Surv. of Montana and Portions of Adjacent Territories, being a fifth annual report of progress, 1872, 467–476.

The material upon which this report was based was collected chiefly in Montana, Idaho, and Utah, but two species of fishes, however, were obtained in a tributary of the Rio Grande at Sangre de Christo Pass, in Colorado. One of these was a minnow, *Leuciscus pulcher*, which Prof. Cope described as *Clinostomus pandora*, while the other was the Rio Grande trout, which was described under the name of *Salmo spilurus*.

1875. Prof. E. D. COPE and Dr. H. C. YARROW. Report upon the Collections of Fishes made in portions of Nevada, Utah, California, New Mexico, and Arizona, during the years 1871, 1872, 1873, and 1874. Zoölogy of the Wheeler Survey, 637–700, 1875.

The geographical explorations and surveys west of the one hundredth meridian, conducted under the direction of Lieut. Geo. M. Wheeler, during the years 1871 to 87 4, inclusive, resulted in greatly increasing our knowledge of the fishes of the upper Rio Grande basin. The naturalists attached to these various expeditions were, as is well known, Dr. H. C. Yarrow, Prof. E. D. Cope, Dr. J. T. Rothrock, Mr. H. W. Henshaw, Dr. Oscar Loew, Mr. W. G. Shedd, Mr. C. E. Aiken, and Lieut. W. L. Marshall. In the report upon the fishes of this survey, written by Cope and Yarrow, 18 species are credited to the Rio Grande basin, of which 5 were described as new to science.

Page.	Nominal species.	Identification.	Locality.	Collector.
639	Scaphirhynchops platyrhynchus.	Scaphirhynchus platyrhynchus.	Rio Grande, at Albuquerque, N. Mex	Dr. Oscar Loew.
639	Lepidosteus sp	Lepisosteus platystomus?	Rio Grande	
639	Anguilla tyrannus	Anguilla chrysypa	Near Santa Fe, N. Mex	Dr. H. C. Yarrow.
644	Rhinichthys maxillosus.	Rhinichthys dulcis	Abiquiu, N. Mex. (Chama River)	Dr. Loew.
			Nutria, N. Mex	W. G. Shedd.
			Costilla Creek, N. Mex	Prof. E. D. Cope.
			Taos and San Ildefonso, N. Mex	Dr. Yarrow.
647	Apocope oscula	Agosia yarrowi	Rio Grande, Colo	Dr. J. T. Rothrock.
			Nutria, N. Mex	W. G. Shedd.
648	Apocope ventricosa	do	"New Mexico"	
649	Alburnellus *simus*	Notropis simus	San Ildefonso, N. Mex	Yarrow and Cope.
650	Alburnellus *jemezanus*	Notropis dilectus	do	Do.
652	Ceratichthys *sterletus*	Hybopsis æstivalis	Rio Grande at San Ildefonso, N. Mex	Do.
653	Hypsilepis *iris*	Notropis lutrensis	San Ildefonso, N. Mex	Do.
660	Gila pandora	Leuciscus nigrescans	Rio Grande at mouth of Rio Honda, N. Mex.	Prof. Cope.
			Rio Grande near San Ildefonso, N. Mex	Dr. Yarrow.
661	Gila *gula*	do	Rio de Acama, N. Mex	H. W. Henshaw.
662	Gila egregia	do	Rio Grande at Loma, Colo	Dr. Rothrock.
672	Hybognathus nuchalis	Hybognathus nuchalis	Rio Grande near San Ildefonso, N. Mex	Yarrow and Cope.
674	Pantosteus jarrovii	Pantosteus plebeius	Costilla, Taos, and San Ildefonso, N. Mex	Do.
681	Carpiodes grayi	Carpiodes velifer tumidus.	San Ildefonso, N. Mex	Prof. Cope.
693	Salmo spilurus	Salmo mykiss spilurus	Brazos River, a small tributary of Chama River, N. Mex.	
693	Salmo pleuriticus	do	Rio Grande, Colo	Henshaw, Rothrock, Marshall, Shedd, Aiken, Cope, and Yarrow.
			Fort Garland, Colo	
			Costilla, N. Mex	
			Taos River, N. Mex	
			Chama River, N. Mex	
			San Ildefonso, N. Mex	

1878. G. BROWN GOODE. A Revision of the American Species of the genus *Breroortia*, with a Description of a new species from the Gulf of Mexico. <Proc. U. S. Nat. Mus. 1878, 30-42.

In this paper Dr. Goode describes the menhaden of the Gulf of Mexico as a new species, proposing for it the name *Brevoortia patronus*. The specimens upon which the species was based were from Brazos Santiago.

1878. DAVID S. JORDAN, M. D. Notes on a Collection of Fishes from the Rio Grande, at Brownsville, Texas. <Bull. U. S. Geol. and Geog. Survey, vol. IV, Nos. 2 and 3, 397-406 and 663-667, May 3, 1878, and July 29, 1878.

In this paper Dr. Jordan gives notes on the species of a small collection of fishes from the Rio Grande at Brownsville. This collection belonged to the National Museum, but when and by whom it was made can not be determined.

The following is a list of the species with the present identification of each. "*Sema signifer*" and "*Decentrus lucens*," names applied in this paper to two supposed new species, should be suppressed for the reason given by Dr. Jordan in the Proc. U. S. Nat. Mus. for 1880, page 327.

Page.	Nominal species.	Identification.	Page.	Nominal species.	Identification.
397	Lepiopomus pallidus	Lepomis pallidus.	403	Cyprinella bubalina	Notropis bubalinus.
398	Apomotis cyanellus	Lepomis cyanellus.	404	Notemigonus chrysoleucus	Notemigonus chrysoleucus.
400	Hydrargyra similis	Fundulus similis.	404	Carpiodes tumidus	Carpiodes velifer tumidus.
401	Campostoma formosulum	Campostoma formosulum.	405	Amiurus natalis antoniensis	Ameiurus natalis.
401	Hybognathus amarus	Dionda amara.	663	Xenotis breviceps	Lepomis megalotis.
401	Hybognathus serenus	Dionda serena.	663	Pœcilichthys lepidus	Etheostoma lepidum.
402	Hybognathus melanops	Dionda melanops.	664	Fundulus zebra	Fundulus zebrinus.
402	Pimephales promelas and later on Pimephales nigellus.	Pimephales promelas confertus.	665	Cyprinella complanata	Notropis lutrensis.
403	Alburnops missuriensis	Notropis deliciosus.	666	Phenacobius scopiferus	Phenacobius mirabilis.
			666	Carpiodes cyprinus	Carpiodes velifer tumidus.

1880. EDWARD D. COPE. On the Zoölogical Position of Texas. Bull. 17, U. S. Nat. Mus., 1880, 1-51.

In this valuable bulletin Professor Cope gives 24 species of fishes, specimens of which were obtained in Texas by himself or his correspondents. Seven of these he described as new. The following is a list of these 24 species:

Page.	Nominal species.	Identification.	Locality.
30	Boleosoma phlox	Etheostoma phlox	Trinity River at Fort Worth.
31	Percina caprodes carbonaria	Etheostoma caprodes	Trinity River near Dallas, and Llano River, Kimble County.
31	Micropterus floridanus	Micropterus salmoides	Trinity, Llano, Guadalupe, and Medina rivers, and Johnson Fork of Llano River in Kimble County.
33	Apomotis cyanellus	Lepomis cyanellus	Trinity River at Dallas and Fort Worth.
33	Apomotis sp		Llano River.
33	Lepomis speciosus	Lepomis pallidus	Do.
33	Lepomis anagallinus var	Lepomis humilis	Trinity River at Fort Worth.
33	Xenotis megalotis	Lepomis megalotis	Trinity River at Fort Worth and Dallas, Helotes Creek, Upper Medina River, and Johnson Fork of Llano River in Kimble County.
33	Fundulus diaphanus	Zygonectes escambiæ	Comanche Creek, in Mason County.
34	Zygonectes notatus	Zygonectes notatus	Trinity River at Fort Worth.
34	Zygonectes *brachypterus*	Gambusia affinis	Do.
34	Ichthælurus cærulescens	Ictalurus punctatus	Trinity River at Dallas and Fort Worth and Little Wichita River.
✓ 34	Amiurus lupus	Ameiurus lupus	Tributary of Medina River.
35	Amiurus *brachyacanthus*	Ameiurus melas	Wallace Creek, Bandera County.
35	Amiurus catus	Ameiurus nebulosus catulus	Little Wichita River.
35	Amiurus *bolli*	Ameiurus natalis bolli	Do.
36	Pelodichthys olivaris	Leptops olivaris	Trinity River at Dallas and Fort Worth.
36	Myxostoma macrolepidotum.	Moxostoma congestum	Guadalupe and Llano Rivers.
36	Campostoma anomalum pullum.	Campostoma anomalum	At Helotes on the Upper Medina and in Comanche Creek, Mason County.
36	Hybognathus *flavipinnis*	Dionda episcopa	Johnson Fork of Llano River, in Kimble County.
37	Hybognathus *nigrotæniata*	Dionda serena	Wallace Creek.
37	Cochlognathus *biguttata*	Cochlognathus ornatus	Trinity River at Fort Worth.
38	Cyprinella venusta	Notropis venustus	Johnson Fork of Llano River.
39	Moniana jugalis, var?	Notropis lutrensis	Trinity River at Dallas and Fort Worth.

1881*a*. SAMUEL GARMAN. New and little-known Reptiles and Fishes in the Museum Collections. Bull. 3, Mus. Comp. Zoöl., vol. VIII, pp. 85-93, February, 1881.

In this paper Prof. Garman gives descriptions of, or notes upon, 20 species of fishes. Of these 20 species, 2 are from Texan localities and 12 others are from the Mexican state of Coahuila. Some of these waters are at present without outlet to the sea, but zoölogically they belong to the Rio Grande Basin.

Page.	Nominal species.	Identification.	Locality.
89	Noturus flavus	Ameiurus natalis	San Antonio, Texas.
89	Ichthyobus tumidus	Carpiodes velifer tumidus	Nazas River at San Pedro, Coahuila.
89	Catostomus *nebuliferus*,	Pantosteus plebeius	Nazas River.
89	Hybognathus (Dionda) *punctifer*.	Dionda punctifer	Parras and spring near Saltillo, Coahuila.
90	Stypodon *signifer*	Stypodon signifer	Parras, Coahuila.
91	Cyprinella *rubripinna*	Notropis garmani	Do.
91	Gila *conspersa*	Leuciscus conspersus	Nazas River, Coahuila.
92	Cheonda nigrescens	Leuciscus pulcher	Parras, Coahuila.
92	Cheonda *modesta*	Leuciscus pulcher?	Saltillo, Coahuila.
92	Astyanax argentatus	Tetragonopterus argentatus	Tributaries of the Lago del Muerte and spring near Monclova.
92	Cyprinodon *latifasciatus*	Cyprinodon latifasciatus	Spring near Parras.
93	Alburnellus megalops	Notropis swaini	Sutherland Springs, Texas.
93	Gambusia patruelis	Gambusia affinis	Monclova, Coahuila.
93	Heros *pavonaceus*	Heros pavonaceus	Spring near Monclova.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Jordan, David S., and Charles H. Gilbert. Synopsis of the Fishes of North America.

In the Synopsis only a few definite Texas localities are given, these being taken from the various preceding papers. There is, therefore, no additional information contained in the Synopsis regarding the geographic distribution of fishes in this State.

[illegible] Jordan, David S., and Seth E. Meek. Description of [illegible] New Species of [illegible] in the United States National Museum. (Proc. U. S. Nat. Mus. [illegible])

One of these four minnows is *Notropis* [illegible], described in this paper as [illegible], from specimens collected in Clear Creek near Georgetown, by Messrs. Ludwig Kumlien and R. Edward Earll, and others collected in the San Saba River by Mr. W. W. Anderson.

1885*a*. DAVID S. JORDAN. Identification of the Species of *Cyprinidæ* and *Catostomidæ* described by Dr. Charles Girard, in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1856. <Proc. U. S. Nat. Mus. 1885, 118–127.

In this is given, in the light of subsequent investigation, the identification of the species of Girard's paper which we have already summarized on page 69. Dr. Jordan's paper contains valuable notes upon many of the types of these species, and the identifications given by him are, in the main, accepted in the present paper.

1885*b*. DAVID STARR JORDAN. A Catalogue of the Fishes known to inhabit the waters of North America, north of the Tropic of Cancer, with notes on the Species discovered in 1883 and 1884. Report U. S. Fish. Comm., 1885.

In this catalogue the localities given are, with few exceptions, such as had already been given in other papers. The few exceptions are chiefly in connection with the species collected in 1884, as given in the next paper.

1886. DAVID S. JORDAN and CHARLES H. GILBERT. List of Fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884, with notes and descriptions. <Proc. U. S. Nat. Mus. 1886, 1–25.

This is by far the most important contribution to our knowledge of the fresh-water fishes of Texas that has appeared in recent years. These collections enabled Girard's species to be more certainly identified than was before possible. The total number of species obtained from Texan localities during these explorations was 53, of which 4 were described as new.

Fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884.

Page.	Species.	Locality.
14	Scaphirhynchops platyrhynchus	Red River at Fulton, Ark.
14, 18, 22	Lepidosteus osseus	Red River at Fulton; Lampasas River near Belton; San Marcos River at San Marcos.
14, 18, 20	Ictalurus punctatus	Red River at Fulton; Lampasas River near Belton; Colorado River at Austin.
14, 17, 18, 20	Leptops olivaris	Red River at Fulton; Trinity River at Dallas; Lampasas River near Belton; Colorado River at Austin.
6, 15, 17, 18	Noturus *nocturnus*	Poteau River at Slate Ford, Ind. T.; Trinity River at Dallas; Lampasas River near Belton; Sabine River at Longview.
20, 22	Amiurus nebulosus catulus	Colorado River (Barton Spring) at Austin; San Marcos River at San Marcos.
14	Ictiobus bubalus	Red River at Fulton.
14	Ictiobus velifer	Do.
18, 20	Ictiobus velifer tumidus	Lampasas River near Belton; Colorado River at Austin.
20	Ictiobus carpio	Colorado River at Austin.
15	Moxostoma pœcilurum	Sabine River at Longview.
18. 20, 22, 23	Moxostoma congestum	Lampasas River near Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
15, 17, 19, 20	Campostoma anomalum	Trinity River at Dallas; Lampasas River at Belton; Colorado River at Austin.
23	Dionda episcopa	Comal Creek at New Braunfels.
14, 15, 17	Hybognathus nuchalis	Red River at Fulton; Sabine River at Longview; Trinity River at Dallas.
20	Pimephales notatus	Colorado River at Austin.
17, 19, 20, 22, 23	Cliola vigilax	Sabine River at Longview; Trinity River at Dallas; Lampasas River at Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14, 15	Notropis dilectus	Red River at Fulton; Sabine River at Longview.
14, 15, 19, 20	Notropis venustus	Red River at Fulton; Sabine River at Longview; Lampasas River at Belton; Colorado River at Austin.
15, 17, 19, 20, 21, 22, 24	Notropis lutrensis	Sabine River at Longview; Trinity River at Dallas; Lampasas River at Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
15	Notropis *sabinæ*	Sabine River at Longview.
19, 22, 23	Notropis deliciosus	Lampasas River at Belton; Comal Creek at New Braunfels; San Marcos River at San Marcos.
17, 19	Notropis texanus	Trinity River at Dallas; Lampasas River at Belton.
20	Notropis notatus	Colorado River at Austin.
21, 22, 24	Notropis swaini	Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14	Hybopsis storerianus	Red River at Fulton.

Fishes collected in Arkansas, Indian Territory, and Texas, in September 1884—Continued.

Page.	Species.	Locality.
14, 21	Hybopsis æstivalis	Red River at Fulton; Colorado River at Austin.
22, 24	Hybopsis æstivalis *marcensis*	San Marcos River at San Marcos; Comal Creek at New Braunfels.
15, 17	Phenacobius mirabilis	Sabine River at Longview; Trinity River at Dallas.
14	Hiodon alosoides	Red River at Fulton.
14	Clupea chrysochloris	Do.
14, 24	Dorosoma cepedianum	Red River at Fulton; Comal Creek at New Braunfels.
14, 16, 17, 19, 21, 22, 24	Gambusia patruelis=affinis	Red River at Fulton; Sabine River at Longview; Trinity River at Dallas; Lampasas River near Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14, 16, 17, 19, 21	Zygonectes notatus	Red River at Fulton; Sabine River at Longview; Trinity River at Dallas; Lampasas River near Belton; Colorado River at Austin.
14, 16, 19, 21, 22, 24	Micropterus salmoides	Red River at Fulton; Sabine River at Longview; Lampasas River near Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14, 17, 21, 24	Lepomis pallidus	Red River at Fulton; Trinity River at Dallas; Colorado River at Austin; Comal Creek at New Braunfels.
16	Lepomis humilis	Sabine River at Longview.
19, 21	Lepomis cyanellus	Lampasas River near Belton; Colorado River at Austin.
19, 21, 23, 24	Lepomis megalotis	Lampasas River near Belton; Colorado River at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14	Pomoxys sparoides	Red River at Fulton.
19	Chænobryttus gulosus	Leon River at Belton.
14	Cottogaster shumardi	Red River at Fulton.
14, 16	Ammocrypta clara	Red River at Fulton; Sabine River at Longview.
16	Ammocrypta vivax	Sabine River at Longview.
16, 17, 19, 23, 24	Hadropterus scierus *serrula*	Sabine River at Longview; Trinity River at Dallas; Lampasas River near Belton; San Marcos and Comal rivers.
16	Etheostoma jessiæ	Sabine River at Longview.
17	Etheostoma fusiforme	Trinity River at Dallas.
19, 21, 23, 24	Etheostoma lepidum	Lampasas River near Belton; Colorado River (Barton Spring) at Austin; San Marcos River at San Marcos; Comal Creek at New Braunfels.
14	Roccus chrysops	Red River at Fulton.
14, 21	Aplodinotus grunniens	Red River at Fulton; Colorado River at Austin.
21	Percina caprodes	Colorado River at Austin.
23	Alvarius fonticola	San Marcos River at San Marcos.
21, 22	Anguilla anguilla rostrata	Barton Spring at Austin; San Marcos Spring.

1890. CHARLES H. GILBERT. Description of a new species of *Etheostoma* (*E. micropterus*) from Chihuahua, Mexico. <Proc. U. S. Nat. Mus. 1890, 289-290.

In this paper is given the description of *Etheostoma micropterus.* The type is a single specimen, 1¾ inches long, collected at Chihuahua, Mexico, by Mr. E. Wilkinson, and is in the U. S. National Museum as No. 38245.

1891. DAVID STARR JORDAN. Report of Explorations in Colorado and Utah during the summer of 1889, with an account of the Fishes found in each of the river basins examined. <Bull. U. S. Fish Commission for 1889, 1-40, plates I-V, May 29, 1891.

During these explorations some work was done in the Rio Grande basin. The species obtained are given in the following table:

Page.	Species.	Locality.
19	Pantosteus plebeius	Rio Grande at Del Norte, Colo.; Rio Grande at Alamosa, Colo.; Rio Conejos near Alamosa, Colo.
20	Leuciscus pulcher	Rio Grande at Del Norte and Alamosa; Rio Conejos near Alamosa.
22	Rhinichthys dulcis	Do.
22	Salmo mykiss spilurus	Rio Grande at Del Norte; Rio Conejos near Alamosa.

1892. A. J. WOOLMAN. New Fishes from Chihuahua, Mexico. < American Naturalist, March, 1892, 259-261.

This paper contains descriptions of two new species of fishes (*Notropis chihuahua* and *Etheostoma scovellii*) collected by Mr. Woolman in the Rio de las Conchas, at Chihuahua, in the summer of 1891.

1892*a*. Barton W. Evermann. Report on the Establishment of Fish-Cultural Stations in the Rocky Mountain region and Gulf States. Senate Mis. Doc. No. 65, Fifty-second Congress, first session, May 25, 1892. Pages I–IV and 1–88; plates I to XXXVI. [Also printed as Articles 1 and 2 of U. S. Fish Commission Bulletin for 1891.]

Part 2 of this report is "A report upon investigations made in Texas in 1891." Of the fishes collected during these investigations only the *Cyprinidæ* and *Cyprinodontidæ* were reported upon at that time. Thirty-one species of these two families were given, ten of which were described as new.

1892*b*. Barton W. Evermann. Description of a new Sucker, *Pantosteus jordani*, from the upper Missouri Basin. < Bull. U. S. Fish Commission for 1892, 51–56, January 27, 1893.

This paper also contains a brief review of the species of the genus *Pantosteus*, together with a list of the specimens now contained in the National Museum and the localities from which they were obtained.

LIST SHOWING THE SPECIES OF EACH FAMILY OF FISHES REPRESENTED IN THE TEXAN AND RIO GRANDE FAUNA.

From the following list it appears that the fishes of this region represent 51 families, 137 genera, and 230 species. The family having the greatest number of species is, of course, the *Cyprinidæ*, the number being 55; the *Cyprinodontidæ* come next with 19 species, and then the *Percidæ* with 16 species. The genus *Notropis* is represented by 27 species, this being the greatest number of species found in this region belonging to a single genus. Of these 230 species, 100 (or 43 per cent) have been taken only in salt water or brackish water, 120 (or 52 per cent) have been recorded only from fresh water, while 10 species (4 per cent) have been taken in both salt and fresh water. The number of fresh-water species known from the Wabash River basin is 130, this being 10 more than the number now known from the vast area covered by this paper; but the Wabash basin is probably the richest in species and individuals of any river basin of similar size in North America. Many of the species of this list have been described as new species, the types of which came from this region. Under each recognized species we have given the various names under which it has been so described.

List showing the species of each family of fishes represented in the Texan and Rio Grande Fauna.

I. Galeorhinidæ.

1. Carcharhinus platyodon (Poey).

II. Pristididæ.

2. Pristis pectinatus Latham.

III. Dasyatidæ.

3. Dasabatis sayi (Le Sueur).
4. Trigon sabina (Le S.).

IV. Aëtobatidæ.

5. Aëtobatis freminvillei (Le S.).

V. Acipenseridæ.

6. Scaphirhynchus platyrhynchus (Raf.).

VI. Lepisosteidæ.

7. Lepisosteus osseus (L.).
8. Lepisosteus platystomus Raf.
Lepidosteus (Cylindrosteus) latirostris Grd.
9. Lepisosteus tristœchus (Bloch & Schneider).
Lepidosteus (Atractosteus) berlandieri Grd.
Lepidosteus leptorhynchus Grd.

VII. Siluridæ.

10. Noturus nocturnus Jordan & Gilbert.
11. Leptops olivaris (Raf.).
12. Ameiurus melas (Raf.).
Amiurus brachyacanthus Cope.
13. Ameiurus nebulosus catulus (Grd.).
14. Ameiurus natalis (Le S.).
Pimelodus antoniensis Grd.
Pimelodus felis Grd.
15. Ameiurus natalis bolli Cope.
16. Ameiurus lupus (Grd.).
17. Ictalurus punctatus (Raf.).
Pimelodus vulpes Grd.
Ichthælus cærulescens Cope.
18. Ictalurus furcatus (C. & V.).
Pimelodus affinis B. & G.
19. Tachysurus felis (L.).
Arius equestris B. & G.
20. Felichthys marinus (Mitchill).

VIII. Catostomidæ.

21. Ictiobus cyprinella (C. & V.).
22. Ictiobus bubalus (Raf.).
23. Carpiodes carpio (Raf.).
24. Carpiodes velifer (Raf.).
25. Carpiodes velifer tumidus B. & G.
Carpiodes grayi Cope.

List showing the species of each family of fishes represented in the Texas and Rio Grande Fauna—Continued.

VIII. CATOSTOMIDÆ—Continued.

26. Pantosteus plebeius (B. & G.).
    Catostomus guzmaniensis Grd.
    Catostomus bernardini Garman.
27. Catostomus teres (Mitchill).
28. Erimyzon sucetta (Lac.).
    Moxostoma kennerlii Grd.
    Moxostoma campbelli Grd.
    Moxostoma claviformis Grd.
29. Minytrema melanops (Raf.).
    Moxostoma victoriæ Grd.
30. Moxostoma congestum (B. & G.).
    Ptychostomus albidus Grd.
31. Moxostoma pœcilurum Jordan.

IX. CYPRINIDÆ.

32. Campostoma ornatum Grd.
33. Campostoma anomalum (Raf.).
    Campostoma nasutum Grd.
    Campostoma anomalum pullum Cope.
34. Campostoma formosulum Grd.
35. Zophendum puniceum (Grd.).
    Hyborhynchus puniceus Grd.
    Dionda grisea Grd.
36. Dionda melanops Grd.
    Dionda couchi Grd.
    Hybognathus melanops Jordan.
37. Dionda punctifer Garman.
38. Dionda fluviatilis (Grd.).
39. Dionda amara (Grd.).
40. Dionda episcopa Grd.
    Dionda texensis Grd.
    Dionda argentosa Grd.
    Hybognathus flavipinnis Cope.
41. Dionda serena Grd.
    Dionda papalis Grd.
    Dionda chrysitis Grd.
    Hybognathus nigrotæniata Cope.
42. Hybognathus nuchalis Agassiz.
43. Pimephales promelas confertus (Grd.).
    Hybognathus nigellus Cope.
44. Pimephales notatus (Raf.).
    Hyborhynchus tenellus Grd.
45. Cochlognathus ornatus B. & G.
    Cochlognathus biguttatus Cope.
46. Cliola vigilax (B. & G.).
    Cliola velox Grd.
    Cliola vivax Grd.
47. Notropis cayuga atrocaudalis Evermann.
48. Notropis nitidus (Grd.).
49. Notropis nux Evermann.
50. Notropis deliciosus (Grd.).
    Alburnops missuriensis Jordan.
51. Notropis sabinæ J. & G.
52. Notropis nocomis Evermann.
53. Notropis simus (Cope).
54. Notropis ornatus (Grd.).
55. Notropis chihuahua Woolman.
56. Notropis formosus (Grd.).
    Moniana frigida Grd.
    Moniana complanata Grd.
57. Notropis lutrensis (B. & G.).
    Moniana couchi Grd.
    Moniana rutila Grd.
    Moniana gracilis Grd.
    Moniana gibbosa Grd.
    Moniana lætabilis Grd.
    Cyprinella suavis Grd.
    Hypsilepis iris Cope.
    Moniana jugalis, var. , Cope.
58. Notropis proserpinus (Grd.).
59. Notropis [illegible] (Grd.).
60. Notropis bubalinus (B. & G.).
    Cyprinella umbrosa Grd.
61. Notropis lepidus (Grd.).
62. Notropis garmani Jordan.
    Cyprinella rubripinna Garman.
63. Notropis macrostomus (Grd.).
    Cyprinella luxiloides Grd.
64. Notropis [illegible] (Grd.).
    Cliola [illegible] Jordan & Meek.
65. Notropis [illegible] (Grd.).
66. Notropis texanus (Grd.).
67. Notropis amabilis (Grd.).
68. Notropis [illegible] (Grd.).
69. Notropis [illegible] J. & G.
    Alburnus megalops Grd.

IX. CYPRINIDÆ—Continued.

70. Notropis [illegible] (Grd.).
71. Notropis dilectus (Grd.).
    Alburnellus jemezanus Cope.
72. Notropis fumeus Evermann.
73. Notropis [illegible] Evermann.
74. Phenacobius mirabilis (Grd.).
75. Rhinichthys [illegible] (Grd.).
    Rhinichthys [illegible] Garman.
76. Agosia [illegible] (Grd.).
    Apocope ventricosa Cope.
77. Agosia yarrowi Jordan & Evermann.
78. Hybopsis storerianus (Kirtland).
79. Hybopsis æstivalis (Grd.).
    Ceratichthys sterletus Cope.
80. Hybopsis æstivalis marconis (J. & G.).
81. Semotilus atromaculatus (Mitch.).
    Leucosomus incrassatus Grd.
    Leucosomus pallidus Grd.
82. Stypodon signifer Garman.
83. Leuciscus nigrescens (Grd.).
    Gila pulchella B. & G.
    Clinostomus pandora Cope.
    Tigoma pulchra Grd.
    Cheonda [illegible] Garman.
84. Leuciscus [illegible] (Garman).
85. Opsopœodus [illegible] Evermann.
86. Notemigonus chrysoleucus (Mitch.).
    Luxilus [illegible] Grd.

X. CHARACINIDÆ.

87. Tetragonopterus argentatus (B. & G.).

XI. HIODONTIDÆ.

88. Hiodon alosoides (Raf.).

XII. ELOPIDÆ.

89. Megalops atlanticus C. & V.

XIII. CLUPEIDÆ.

90. Clupea chrysochloris (Raf.).
91. Harengula arcuata (Jenyns).
92. Opisthonema thrissa (Osbeck).
93. Brevoortia tyrannus patronus Goode.
94. Dorosoma cepedianum (Le S.).

XIV. ENGRAULIDÆ.

95. Stolephorus browni (Gmelin).
96. Stolephorus mitchilli (C. & V.).

XV. SYNODONTIDÆ.

97. Synodus fœtens (L.).

XVI. SALMONIDÆ.

98. Salmo mykiss spilurus Cope.
    Salmo virginalis Cope.

XVII. CYPRINODONTIDÆ.

99. Cyprinodon variegatus Lac.
    Cyprinodon gibbosus B. & G.
    Cyprinodon bovinus B. & G.
    Cyprinodon eximius Grd.
100. Cyprinodon latifasciatus Garman.
101. Cyprinodon elegans B. & G.
102. Adinia multifasciata Grd.
103. Fundulus pallidus Evermann.
104. Fundulus similis (B. & G.).
105. Fundulus zebrinus J. & G.
106. Fundulus diaphanus (Le S.).
107. Fundulus heteroclitus grandis (B. & G.).
108. Zygonectes funduloides Evermann.
109. Zygonectes pulvereus Evermann.
110. Zygonectes jenkinsi Evermann.
111. Zygonectes notatus (Raf.).
112. Zygonectes [illegible] Bollman.
113. Lucania venusta (Grd.).
114. Lucania parva (B. & G.).
115. Gambusia affinis (B. & G.).
    Heterandria nobilis B. & G.
    Heterandria patruelis B. & G.
    Gambusia gracilis Grd.
    Gambusia humilis Günther.
    Zygonectes [illegible] Cope.
    Gambusia speciosa Grd.
    Gambusia senilis Grd.

List showing the species of each family of fishes represented in the Texan and Rio Grande Fauna—Continued.

XVII. CYPRINODONTIDÆ—Continued.

116. Mollienesia latipinna Le S.
  Pœcelia lineolata Grd.
  Limia pœcilioides Grd.
  Limia matamorensis Grd.
  Limia formosa Grd.
117. Pœcilia couchiana (Grd.).

XVIII. ESOCIDÆ.

118. Lucius vermiculatus (Le S.).

XIX. MURÆNIDÆ.

119. Gymnothorax ocellatus nigromarginatus (Grd.).

XX. ECHELIDÆ.

120. Myrophis punctatus Lutken.
  Myrophis lumbricus J. & G.

XXI. MURÆNESOCIDÆ.

121. Neoconger mucronatus Grd.

XXII. ANGUILLIDÆ.

122. Anguilla chrysypa Raf.

XXIII. SCOMBERESOCIDÆ.

123. Tylosurus longirostris (Mitchill).
  Belone scrutator Grd.
124. Hemirhamphus unifasciatus Ranzani.

XXIV. SYNGNATHIDÆ.

125. Siphostoma floridæ J. & G.
126. Siphostoma louisianæ (Günther).
127. Siphostoma fuscum (Storer).

XXV. MUGILIDÆ.

128. Mugil cephalus L.
  Mugil berlandieri Grd.

XXVI. ATHERINIDÆ.

129. Labidesthes sicculus (Cope).
130. Menidia vagrans (Goode & Bean).
131. Menidia peninsulæ (Goode & Bean).

XXVII. POLYNEMIDÆ.

132. Polynemus octonemus Grd.

XXVIII. TRICHIURIDÆ.

133. Trichiurus lepturus L.

XXIX. CARANGIDÆ.

134. Caranx hippos (L.).
135. Vomer setipinnis (Mitch.).
136. Selene vomer (L.).
137. Chloroscombrus chrysurus (L.).
  Chloroscombrus caribbæus Grd.
138. Trachynotus carolinus (L.).
139. Oligoplites saurus (Bloch & Schneider).
  Chorinemus lanceolatus Grd.

XXX. APHREDODERIDÆ.

140. Aphredoderus sayanus (Gilliams).

XXXI. CENTRARCHIDÆ.

141. Pomoxis annularis Raf.
142. Pomoxis sparoides (Lac.).
143. Chænobryttus gulosus (C. & V.).
  Calliurus melanops Grd.
144. Lepomis cyanellus Raf.
  Calliurus formosus Grd.
  Calliurus diaphanus Grd.
  Pomotis longulus B. & G.
  Bryttus signifer Grd.
  Calliurus microps Grd.
  Calliurus murinus Grd.
145. Lepomis symmetricus Forbes.
146. Lepomis miniatus Jordan.

XXXI. CENTRARCHIDÆ—Continued.

147. Lepomis megalotis (Raf.).
  Pomotis breviceps B. & G.
  Pomotis convexifrons B. & G.
  Pomotis fallax B. & G.
  Pomotis nefastus B. & G.
  Pomotis popeii Grd.
148. Lepomis humilis (Grd.).
  Lepomis anagallinus var. Cope.
149. Lepomis pallidus (Mitch.).
  Pomotis aquilensis B. & G.
  Pomotis speciosus B. & G.
150. Lepomis heros (B. & G.).
151. Lepomis albulus (Grd.).
152. Micropterus salmoides (Lac.).
  Grystes nuecensis B. & G.

XXXII. PERCIDÆ.

153. Etheostoma pellucidum clarum (Jordan & Meek).
154. Etheostoma vivax (Hay).
155. Etheostoma phlox (Cope).
156. Etheostoma chlorosoma (Hay).
157. Etheostoma shumardi (Grd.).
158. Etheostoma caprodes (Raf.).
  Pileoma carbonaria B. & G.
159. Etheostoma fasciatus (Grd.).
160. Etheostoma sciērum serrula (J. & G.).
161. Etheostoma lepidum (B. &G.).
162. Etheostoma lepidogenys sp. nov.
163. Etheostoma micropterus Gilbert.
164. Etheostoma australe Jordan.
  Etheostoma scovelli Woolman.
165. Etheostoma jessiæ (Jordan & Brayton).
166. Etheostoma fusiforme (Grd.).
  Boleosoma gracile Grd.
167. Etheostoma lateralis (Grd.).
168. Etheostoma fonticola J. & G.

XXXIII. SERRANIDÆ.

169. Centropomus undecimalis (Bloch).
170. Roccus chrysops (Raf.).
171. Morone interrupta Gill.

XXXIV. SPARIDÆ.

172. Lutjanus caxis (Bloch & Schneider).
173. Lutjanus aya (Bloch).
174. Rhomboplites aurorubens (C. & V.).
175. Orthopristis chrysopterus (L.).
  Orthopristis duplex Grd.
176. Lagodon rhomboides (L.).
177. Archosargus probatocephalus (Walb.).

XXXV. SCIÆNIDÆ.

178. Aplodinotus grunniens Raf.
179. Pogonias chromis (L.).
180. Stelliferus lanceolatus (Holbrook).
181. Bairdiella chrysura (Lac.).
182. Sciæna ocellata (L.).
183. Leiostomus xanthurus Lac.
184. Larimus fasciatus Holbrook.
185. Micropogon undulatus (L.).
186. Menticirrhus littoralis (Holbrook).
187. Menticirrhus americanus (L.).
  Umbrina phalæna Grd.
188. Cynoscion nothus (Holbrook).
189. Cynoscion nebulosus (C. & V.).

XXXVI. GERRIDÆ.

190. Gerres gula (C. & V.).
191. Gerres gracilis (Gill).

XXXVII. CICHLIDÆ.

192. Heros cyanoguttatus (B. & G.).
193. Heros pavonaceus Garman.

XXXVIII. EPHIPPIDÆ.

194. Chætodipterus faber (Broussonet).

XXXIX. GOBIIDÆ.

195. Gobiomorus dormitator (Bl. & Sch.).
196. Dormitator maculatus (Bloch).
  Eleotris sumnulentus Grd.
197. Gobius lyricus Grd.
198. Gobius soporator C. & V.
  Gobius catulus Grd.
199. Gobius boleosoma J. & G.

List showing the species of each family of fishes represented in the Texan and Rio Grande Fauna—Continued.

XXXIX. GOBIIDÆ—Continued.

200. Gobius würdemanni Grd.
201. Gobionellus oceanicus (Pallas).
    Gobionellus hastatus Grd.
202. Lepidogobius gulosus (Grd.).
203. Gobiosoma bosci (Lac.).
204. Gobiosoma molestum Grd.

XL. TRIGLIDÆ.

205. Prionotus scitulus J. & G.
206. Prionotus tribulus C. & V.

XLI. GOBIESOCIDÆ.

207. Gobiesox virgatulus J. & G.

XLII. BATRACHIDÆ.

208. Batrachus tau (L.).
209. Porichthys porosissimus (C. & V.).
    Porichthys plectrodon J. & G.

XLIII. URANOSCOPIDÆ.

210. Upsilonphorus y-græcum (C. & V.).
211. Astroscopus anoplos (C. & V.).

XLIV. BLENNIIDÆ.

212. Chasmodes bosquianus (Lac.).
213. Isesthes hentzi (Le S.).
214. Isesthes ionthas J. & G.
215. Isesthes scrutator J. & G.
216. Hypleurochilus geminatus (Wood).
    Blennius multifilus Grd.

XLV. OPHIDIIDÆ.

217. Ophidion marginatum De Kay.
    Ophidion josephi Grd.

XLVI. PLEURONECTIDÆ.

218. Citharichthys spilopterus Günther.
219. Etropus crossotus J. & G.
220. Paralichthys lethostigma J. & G.
221. Ancylopsetta quadrocellata Gill.
222. Achirus fasciatus Lac.
223. Symphurus plagiusa (L.).

XLVII. ANTENNARIIDÆ.

224. Pterophryne histrio (L.).

XLVIII. MALTHIDÆ.

225. Malthe vespertilio (L.).

XLIX. OSTRACIIDÆ.

226. Ostracion tricorne L.

L. BALISTIDÆ.

227. Alutera schœpfii (Walb.).

LI. TETRODONTIDÆ.

228. Lagocephalus lævigatus (L.).
229. Tetrodon nephelus Goode & Bean.
230. Chilomycterus schœpfii (Walb.).

LIST OF NOMINAL SPECIES WHICH HAVE BEEN DESCRIBED FROM TEXAN OR RIO GRANDE LOCALITIES.

Each of the 125 species of the following list has been described as new one or more times from this region. The total number of nominal species whose types came from this region is 194; of this number only 80 are now regarded as good species. In the following table we give, in the first column the tenable species, in the second the nominal species; the date of the specific name is given in the third column, while in the fourth column is given the locality from which the types came.

List of nominal species which have been described from Texan or Rio Grande localities.

Species now recognized.	Nominal species.	Date.	Type locality.
1. **Lepisosteus platystomus Raf**	1. **Lepidosteus (Cylindrosteus) latirostris Grd.**	1858	Pecos River.
2. **Lepisosteus tristœchus (Bl. & Sch.).**	2. **Lepidosteus (Atractosteus) berlandieri Grd.**	1858	Tamaulipas, Mexico.
	3. **Lepidosteus leptorhynchus Grd.**	1858	Devil River, Texas.
3. **Noturus nocturnus J. & G.**	4. **Noturus nocturnus J. & G**	1884	Poteau River near Fort Smith, Ark.
4. **Ameiurus melas (Raf.)**	5. **Ameiurus brachyacanthus Cope**	1880	Wallace Creek, in Bandera County.
5. **Ameiurus nebulosus catulus (Grd.).**	6. **Ameiurus nebulosus catulus (Grd.).**	1858	Fort Smith, Ark.
6. **Ameiurus natalis (Le S.)**	7. **Pimelodus antoniensis Grd**	1858	Near San Antonio.
	8. **Pimelodus felinus Grd**	1858	Tributary of Gypsum Creek.
7. **Ameiurus natalis bolli Cope**	9. **Ameiurus natalis bolli Cope**	1880	Little Wichita River, northern Texas.
8. **Ameiurus lupus (Grd.)**	10. **Pimelodus lupus Grd**	1856	Indianola to Nueces, and headwaters of Pecos River.
9. **Ictalurus punctatus (Raf.)**	11. **Pimelodus vulpes Grd**	1859	Salado River.
	12. **Ichthælurus cærulescens Cope.**	1880	Little Wichita River.
10. **Ictalurus furcatus (Cuv. & Val.)**	13. **Pimelodus affinis B. & G**	1854	Mouth of Rio Grande near Brownsville.
11. **Tachysurus felis (L.)**	14. **Arius equestris B. & G**	1854	Indianola.
12. **Carpiodes velifer tumidus B. & G.**	15. **Carpiodes tumidus B. & G**	1854	Near Fort Brown.
	16. **Carpiodes grayi Cope**	1870	San Ildefonso, N. Mex.
13. **Pantosteus plebeius (B. & G.)**	17. **Catostomus plebeius B. & G**	1854	Rio Mimbres, Chihuahua.
	18. **Catostomus (Acomus) guzmaniensis Grd.**	1856	Janos River.
	19. **Catostomus nebuliferus Gar**	1881	Nazas River, Coahuila.

List of nominal species which have been described from Texan or Rio Grande localities—Continued.

Species now recognized.	Nominal species.	Date.	Type locality.
14. Erimyzon sucetta (Lac.)	20. Moxostoma kennerlii Grd	1856	Dry Creek near Victoria.
	21. Moxostoma campbelli Grd	1856	Devil River, Live Oak Creek.
	22. Moxostoma claviformis Grd	1856	Coal Creek (tributary of South Fork of Canadian River).
15. Minytrema melanops (Raf.)	23. Moxostoma victoriae Grd	1856	Dry Creek near Victoria.
16. Moxostoma congestum (B. & G.)	24. Catostomus congestus B. & G	1854	Rio Salado.
	25. Ptychostomus albidus Grd	1856	Rio San Juan near Monterey, New Leon.
17. Campostoma ornatum Grd	26. Campostoma ornatum Grd	1856	Chihuahua River and a tributary only a few miles long.
18. Campostoma anomalum (Raf.)	27. Campostoma nasutum Grd	1856	Cadereita and near Monterey, New Leon.
19. Campostoma formosulum Grd	28. Campostoma formosulum Grd	1856	Rio Sabinal, a tributary of the San Antonio.
20. Zophendum plumbeum (Grd.)	29. Dionda plumbea Grd	1856	Headwaters of the Canadian River, Llano Estacado.
	30. Dionda grisea Grd	1858	20 miles west of the Choctaw Agency.
	31. Hyborhynchus puniceus Grd	1856	Llano Estacado.
21. Dionda melanops Grd	32. Dionda melanops Grd	1856	Buena Vista, Coahuila.
	33. Dionda couchi Grd	1856	Cuajuco, Monterey, and Cadereita, New Leon, in the San Juan River.
22. Dionda punctifer Garman	34. Hybognathus (Dionda) punctifer Garman.	1881	Parras, and spring near Saltillo.
23. Dionda fluviatilis (Grd.)	35. Algoma fluviatilis Grd	1856	Near Monterey, New Leon.
24. Dionda amara (Grd.)	36. Algoma amara Grd	1856	Lagoon near Fort Brown on the Rio Grande.
25. Dionda episcopa Grd	37. Dionda episcopa Grd	1856	Headwaters of the Pecos River, and Comanche Spring.
	38. Dionda texensis Grd	1856	Nueces River.
	39. Dionda argentosa Grd	1856	San Felipe Creek and Devil Creek (tributaries of Rio Grande).
	40. Hybognathus flavipinnis Cope	1880	Johnson Fork of Llano River, Kimble County.
26. Dionda serena Grd	41. Dionda serena Grd	1856	Sabinal River.
	42. Dionda papalis Grd	1856	Delaware River (tributary of Pecos River).
	43. Dionda chrysitis Grd	1856	Live Oak Creek.
	44. Hybognathus nigrotæniata Cope.	1880	Upper waters of Wallace Creek.
27. Pimephales promelas confertus (Grd.).	45. Hybognathus nigellus Cope	1875	San Ildefonso, N. Mex.
28. Pimephales notatus (Raf.)	46. Hyborhynchus tenellus Grd	1856	20 miles west of Choctaw Agency.
Cochlognathus B. & G	Cochlognathus B. & G	1854	Brownsville.
29. Cochlognathus ornatus B. & G	47. Cochlognathus ornatus B. & G	1854	Do.
	48. Cochlognathus biguttata Cope	1880	Trinity River at Fort Worth.
30. Cliola vigilax (B. & G.)	49. Ceratichthys vigilax B. & G	1853	Otter Creek, Arkansas.
	50. Cliola velox Grd	1856	San Pedro Creek.
	51. Cliola vivax Grd	1856	Leon River (tributary of San Antonio River).
31. Notropis nitidus (Grd.)	52. Moniana nitida Grd	1856	Cadereita, New Leon.
32. Notropis deliciosus (Grd.)	53. Moniana deliciosa Grd	1856	Leon River (tributary of San Antonio)
33. Notropis sabinæ J. & G	54. Notropis sabinæ J. & G	1886	Sabine River, Longview.
34. Notropis simus (Cope)	55. Alburnellus simus Cope	1875	San Ildefonso, N. Mex.
35. Notropis ornatus (Grd.)	56. Codoma ornata Grd	1856	Chihuahua River and tributaries.
36. Notropis chihuahua Woolman	57. Notropis chihuahua Woolman	1892	Rio de las Conchas, Chihuahua.
37. Notropis leoninus (Grd.)	58. Moniana leonina Grd	1856	Leon River (tributary of San Antonio)
	59. Moniana frigida Grd	1856	Rio Frio.
	60. Moniana complanata Grd	1856	Brownsville.
38. Notropis lutrensis (B. & G.)	61. Leuciscus lutrensis B. & G	1853	Otter Creek, Arkansas.
	62. Moniana couchi Grd	1856	China, New Leon.
	63. Moniana rutila Grd	1856	Cadereita, New Leon.
	64. Moniana gracilis Grd	1856	Near Monterey, New Leon.
	65. Moniana gibbosa Grd	1856	Brownsville.
	66. Moniana lætabilis Grd	1856	Hurrah Creek.
	67. Cyprinella suavis Grd	1856	Near San Antonio.
	68. Hypsilepis iris Cope	1875	San Ildefonso, N. Mex.
39. Notropis proserpina (Grd.)	69. Notropis proserpina Grd	1856	Devil River.
	70. Moniana aurata Grd	1856	Piedra Painte, N. Mex.
40. Notropis formosus (Grd.)	71. Moniana formosa Grd	1856	Rio Mimbres, Chihuahua.
41. Notropis bubalinus (B. & G.)	72. Leuciscus bubalinus B. & G	1853	Otter Creek, Arkansas.
	73. Cyprinella umbrosa Grd	1856	Coal Creek, and 20 miles west of Choctaw Agency.
42. Notropis lepidus (Grd.)	74. Cyprinella lepida Grd	1856	Rio Frio.
43. Notropis garmani Jor	75. Notropis garmani Jor	1885	Tributaries of Lage del Muerte, Coahuila.
	76. Cyprinella rubripinna Gar	1881	Tributaries of Lage del Muerte.
44. Notropis macrostomus (Grd.)	77. Cyprinella macrostoma Grd	1856	Devil River, and China, New Leon.
	78. Cyprinella luxiloides Grd	1856	San Pedro Creek.
45. Notropis notatus (Grd.)	79. Cyprinella notata Grd	1856	Rio Seco (tributary of Nueces River).
46. Notropis texanus (Grd.)	80. Cyprinella texana Grd	1856	Rio Salado and Turkey Creek.
47. Notropis venustus (Grd.)	81. Cyprinella venusta Grd	1856	Rio Sabinal.

List of nominal species which have been described from Texan or Rio Grande localities.—Continued.

Species now recognized.	Nominal species.	Date.	Type locality.
48. Notropis amabilis (Grd.)	82. Alburnus amabilis Grd	1856	Leona River (tributary of Nueces River).
49. Notropis socius (Grd.)	83. Alburnus socius Grd	1856	Live Oak Creek.
50. Notropis swaini J. & G	84. Alburnus megalops Grd	1856	San Felipe Creek.
51. Notropis umbratilis (Grd.)	85. Luxilus lucidus Grd	1856	Coal Creek, and 20 miles west of Choctaw Agency.
52. Notropis dilectus (Grd.)	86. Alburnellus jemezanus Cope	1875	San Ildefonso, N. Mex.
53. Notropis fumeus Evermann	87. Notropis fumeus Evermann	1892	Hunter Creek, near Houston.
54. Notropis notemigonoides Ev	88. Notropis notemigonoides Ev	1892	Neches River east of Palestine and Sims Bayou near Houston.
55. Rhinichthys dulcis (Grd.)	89. Rhinichthys simus Garman	1881	Coahuila, Mexico.
56. Agosia oscula (Grd.)	90. Apocope ventricosa Cope	1875	"New Mexico" and "Rio Grande basin."
57. Agosia yarrowi Jor. & Ev	91. Apocope oscula Cope & Yar	1875	Rio Grande, Colorado.
58. Hybopsis æstivalis (Grd.)	92. Gobio æstivalis Grd	1856	Rio San Juan, near Cadereita, New Leon.
	93. Ceratichthys sterletus Cope	1875	Rio Grande at San Ildefonso, N. Mex.
59. Semotilus atromaculatus (Mitch.).	94. Leucosomus incrassatus Grd	1856	20 miles west of Choctaw Agency.
	95. Leucosomus pallidus Grd	1856	Antelope Creek, Arkansas.
60. Stypodon signifer Garman	96. Stypodon signifer Garman	1881	Parras, Coahuila.
61. Leuciscus nigrescens (Grd.)	97. Gila pulchella B. & G	1854	Rio Mimbres.
	98. Tigoma pulchra Grd	1856	Chihuahua River and tributaries.
	99. Clinostoma pandora Cope	1877	Tributary of Rio Grande at Sangre de Christo Pass.
	100. Tigoma nigrescens Grd	1856	Boca Grande and Janos River.
	101. Gila gula Cope & Yarrow	1875	Rio de Acama, N. Mex.
	102. Gila egregia C. & Y	1875	Rio Grande at Loma, Colorado.
62. Leuciscus conspersus (Gar.)	103. Gila conspersus Garman	1881	Nazas River.
	104. Cheonda modesta Garman	1881	Saltillo, Coahuila.
63. Opsopœodus oscula Evermann.	105. Opsopœodus oscula Evermann.	1892	Neches River and Long Lake near Palestine, Buffalo and Sims bayous, and Kilper's Pond near Houston, Dickinson Bayou at Nicholstone.
64. Notemigonus chrysoleucus (Mitch.).	106. Luxilus seco Grd	1856	Rio Seco.
	107. Luxilus leptosomus Grd	1856	Dry Creek near Victoria.
65. Tetragonopterus argentatus (B. & G.).	108. Astyanax argentatus B. & G	1854	Upper tributaries of the Rio Nueces.
66. Brevoortia tyrannus patronus Goode.	109. Brevoortia patronus Goode	1878	Brazos Santiago.
67. Salmo mykiss spilurus Cope	110. Salmo spilurus Cope	1872	Tributary of Rio Grande at Sangre de Christo Pass, Colorado.
	111. Salar virginalis Grd	1856	Utah Creek and Rio Grande at Sangre de Christo Pass.
68. Cyprinodon variegatus B. & G.	112. Cyprinodon gibbosus B. & G	1853	Indianola (brackish water).
	113. Cyprinodon bovinus B. & G	1853	Leon Springs.
69. Cyprinodon latifasciatus Gar	114. Cyprinodon latifasciatus Gar	1881	Spring near Parras, Coahuila.
70. Cyprinodon elegans B. & G	115. Cyprinodon elegans B. & G	1853	Rio Grande.
Adinia Grd	Adinia Grd	1859	Galveston, St. Joseph Island, and Indianola.
71. Adinia multifasciata Grd	116. Adinia multifasciata Grd	1859	Do.
	117. Fundulus adinia Jordan	1883	Do.
	118. Fundulus xenicus Jordan	1892	Galveston.
72. Fundulus pallidus Evermann	119. Fundulus pallidus Evermann	1892	Galveston Bay near Swan Lake.
73. Fundulus similis (B. & G.)	120. Hydrargyra similis B. & G	1853	Indianola (brackish water).
74. Fundulus heteroclitus grandis B. & G.	121. Fundulus grandis B. & G	1853	Near Indianola (brackish water).
75. Zygonectes funduloides Ev	122. Zygonectes funduloides Ev	1892	Dickinson Bayou near Dickinson.
76. Zygonectes pulvereus Ev	123. Zygonectes pulvereus Ev	1892	Dickinson Bayou near Dickinson, Buffalo Bayou near Houston, and Oso Creek near Corpus Christi.
77. Zygonectes jenkinsi Evermann.	124. Zygonectes jenkinsi Evermann.	1892	Dickinson Bayou near Dickinson, and Galveston Bay.
Lucania Grd	Lucania Grd	1859	Indianola.
78. Lucania venusta (Grd.)	125. Limia venusta Grd	1859	Do.
	126. Lucania affinis Grd	1859	Matamoras.
79. Gambusia affinis (B. & G.)	127. Heterandria patruelis B. & G	1853	Nueces basin, particularly Sabinal, Leona, and Nueces rivers, and Elm Creek.
	128. Heterandria affinis B. & G	1853	Medina and Salado rivers.
	129. Heterandria nobilis B. & G	1853	Leona and Comanche Springs.
	130. Gambusia gracilis Grd	1859	Matamoras.
	131. Gambusia humilis Günther	1866	Do.
	132. Zygonectes brachypterus Cope.	1880	Trinity River at Fort Worth.
	133. Gambusia speciosa Grd	1859	Rio San Diego near Cadereita, New Leon.
	134. Gambusia senilis Grd	1859	Chihuahua River.
80. Mollienesia latipinna LeS	135. Pœcilia lineolata Grd	1859	Brownsville and Fort Brown.
	136. Limia pœciloides Grd	1859	Indianola.
	137. Limia matamorensis Grd	1859	Matamoras.
	138. Limia formosa Grd	1859	
81. Pœcilia couchiana (Grd.)	139. Limia couchiana Grd	1859	Rio San Juan at Cadereita and Monterey, New Leon.

List of nominal species which have been described from Texan or Rio Grande localities—Continued.

Species now recognized.	Nominal species.	Date.	Type locality.
82. Gymnothorax ocellatus nigromarginatus (Grd.).	140. Neomuræna nigromarginata Grd.	1859	St. Joseph Island.
83. Myrophis punctatus Lutken	141. Myrophis lumbricus J. & G	1882	Galveston.
84. Neoconger mucronatus Grd	142. Neoconger mucronatus Grd	1859	St. Joseph Island.
85. Anguilla chrysypa Raf	143. Anguilla tyrannus Grd	1859	Mouth of Rio Grande and Matamoras.
86. Tylosurus longirostris (Mitch)	144. Belone scrutator Grd	1859	Brazos and St. Joseph Island.
87. Mugil cephalus L	145. Mugil berlandieri Grd	1859	St. Joseph Island, Indianola, Brazos Santiago, Brazos, and Galveston.
88. Polynemus octonemus Grd	146. Polynemus octonemus Grd	1859	Brazos Santiago and Galveston.
89. Caranx hippos (L.)	147. Carangus esculentus Grd	1859	Brazos Santiago, mouth of Rio Grande.
90. Chloroscombrus chrysurus (L.)	148. Chloroscombrus caribbæus Grd	1859	St. Joseph Island.
91. Oligoplites saurus (Bl. & Sch.)	149. Chorinemus lanceolatus Grd	1859	Do.
92. Chænobryttus gulosus (C. & V.)	150. Calliurus melanops Grd	1857	Leon and Medina rivers, and Dry and San Pedro creeks.
93. Lepomis cyanellus Raf	151. Calliurus formosus Grd	1857	Tributary of Gypsum Creek, headwaters of the Brazos and Colorado rivers, Red River at Fort Washita, and the Brazos River.
	152. Pomotis longulus B. & G	1853	Otter Creek, Arkansas.
	153. Bryttus signifer Grd	1857	Medina River.
	154. Calliurus microps Grd	1857	Red River at Fort Washita, and Brazos River.
	155. Calliurus murinus Grd	1857	Indianola to Nueces, Delaware Creek, and headwaters of Brazos River.
94. Lepomis megalotis (Raf.)	156. Pomotis convexifrons B. & G	1854	Cibolo River.
	157. Pomotis breviceps B. & G	1853	Otter Creek, Arkansas.
	158. Pomotis fallax B. & G	1854	Elm Creek.
	159. Pomotis nefastus B. & G	1854	Cibolo and Salado rivers.
	160. Pomotis popei Grd	1858	Headwaters of Colorado River.
95. Lepomis humilis (Grd.)	161. Bryttus humilis Grd	1857	Brazos River.
96. Lepomis pallidus (Mitch.)	162. Pomotis aquilensis B. & G	1853	Eagle Pass.
	163. Pomotis speciosus B. & G	1854	Brownsville.
	164. Pomotis heros B. & G	1854	
	165. Pomotis heros B. & G	1854	Cibolo River.
97. Lepomis albulus (Grd.)	166. Bryttus albulus Grd	1857	Blanco River.
98. Micropterus salmoides (Lac.)	167. Grystes nuecensis B. & G	1854	Frio and Nueces rivers.
99. Etheostoma phlox (Cope)	168. Boleosoma phlox Cope	1880	Trinity River near Fort Worth.
100. Etheostoma caprodes (Raf.)	169. Pileoma carbonaria B. & G	1853	Salado River.
101. Etheostoma fasciatus (Grd.)	170. Diplesion fasciatus Grd	1859*b*	Chihuahua River.
102. Etheostoma scierum serrula J. & G.	171. Hadropterus scierus serrula J. & G.	1886	Sabine River at Longview.
103. Etheostoma lepidum (B. & G.)	172. Boleosoma lepida B. & G	1853	Nueces River (upper tributaries).
104. Etheostoma micropterus Gilb	173. Etheostoma micropterus Gil	1890	Chihuahua, Mexico.
105. Etheostoma australe Jordan	174. Etheostoma australe Jordan	1892	Chihuahua River.
	175. Etheostoma scovelli Woolman	....	Rio de las Conchas, Chihuahua.
106. Etheostoma fusiforme (Grd.)	176. Boleosoma gracile Grd	1859*b*	Seco and Leona rivers.
107. Etheostoma lepidogenys Evermann & Kendall.	177. Etheostoma epidogenys Evermann & Kendall.	1893	Comal Springs, New Braunfels.
108. Etheostoma lateralis (Grd.)	178. Alvarius lateralis Grd	1859*b*	Mouth of Rio Grande.
109. Etheostoma fonticola J. & G	179. Alvarius fonticola J. & G	1886	San Marcos River at San Marcos.
110. Orthopristis chrysopterus (L)	180. Orthopristis duplex Grd	1859	Indianola and Brazos Santiago.
111. Aplodinotus grunniens Raf	181. Amblodon neglectus Grd	1859	Mouth of Rio Grande and Matamoras..
112. Menticirrhus americanus (L.)	182. Umbrina phalæna Grd	1859	Indianola and Brazos Santiago.
113. Heros cyanoguttatus (B. & G)	183. Heros cyanoguttatus B. & G	1854	Brownsville (fresh water).
114. Heros pavonaceus Garman	184. Heros pavonaceus Garman	1881	Spring near Monclova, Coahuila.
115. Dormitator maculatus (Bloch)	185. Eleotris sumnulentus Grd	1859	Mouth of Rio Grande.
116. Gobius lyricus Grd	186. Gobius lyricus Grd	1858	Brazos Santiago.
117. Gobius soporator (Cuv. & Val.)	187. Gobius catulus Grd	1859	St. Joseph Island.
118. Gobius würdemanni Grd	188. Gobius würdemanni Grd	1859	Brazos Santiago.
119. Gobionellus oceanicus (Pallas)	189. Gobionellus hastatus Grd	1859	St. Joseph Island.
120. Lepidogobius gulosus Grd	190. Lepidogobius gulosus Grd	1858	Indianola.
121. Gobiosoma molestum Grd	191. Gobiosoma molestum Grd	1859	Do.
122. Porichthys porosissimus (C. & V.).	192. Porichthys plectrodon J. & G	1882	Galveston.
123. Isesthes scrutator J. & G	193. Isesthes scrutator J. & G	1882	Do.
124. Hypleurochilus geminatus (Wood).	194. Blennius multifilus Grd	1859	St. Joseph Island.
125. Ophidion marginatum DeKay	195. Ophidion josephi Grd	1859	Do.

FISHES OF THE MEXICAN PORTION OF THE RIO GRANDE BASIN.

The number of species which have been reported from the Mexican portion of the Rio Grande basin is 54. Of this number, 16 species (indicated in the following list by an *) have not as yet been collected from any United States locality. The remaining 38 species have been found either in the Rio Grande or on the Texan side of that stream. Those species which are regarded as belonging properly to the Mexican fauna, but which have extended their range into Texas (9 in number), are indicated by the †. Those species which belong to the fauna of the southwestern United States, but which have spread more or less into Mexico (29 in number), are indicated by the ‡.

In Dr. Eigenmann's recent list of the fresh-water fishes of Central America and southern Mexico,* only 5 species are named which are also found in the Rio Grande basin. These five are *Gambusia gracilis* (= *affinis*), *Pœcilia couchii* (*couchiana*), *Tetragonopterus argentatus*, *Gobiomorus dormitator*, and *Dormitator maculatus*. No Mexican locality is given for *Tetragonopterus argentatus*. We have not been able to find any Mexican reference nor the basis for the statement "Arkansas to Mexico" given in Jordan and Gilbert's Synopsis and repeated in this paper by Dr. Eigenmann.

1. **Lepisosteus tristœchus.** ‡
2. **Leptops olivaris** ‡.
3. **Ictalurus punctatus.** ‡
4. **Ictalurus furcatus.** ‡
5. **Carpiodes velifer tumidus.** †
6. **Pantosteus plebeius.** ‡
7. **Campostoma ornatum.** *
8. **Campostoma anomalum.** ‡
9. **Campostoma formosulum.** ‡
10. **Dionda melanops.** †
11. **Dionda punctifer.** *
12. **Dionda fluviatilis.** *
13. **Dionda amara.** †
14. **Cochlognathus ornatus.** †
15. **Notropis nitidus.** *
16. **Notropis chihuahua.** *
17. **Notropis ornatus.** *
18. **Notropis leoninus.** ‡
19. **Notropis lutrensis.** ‡
20. **Notropis formosus.** *
21. **Notropis bubalinus.** ‡
22. **Notropis garmani.** *
23. **Phenacobius mirabilis.** ‡
24. **Rhinichthys dulcis.** ‡
25. **Hybopsis æstivalis.** Occurrence in Mexico doubtful. ‡
26. **Stypodon signifer.** *
27. **Leuciscus nigrescens.** ‡
28. **Leuciscus conspersus.** *
29. **Tetragonopterus argentatus.** †
30. **Salmo mykiss spilurus.** ‡
31. **Cyprinodon variegatus.** ‡
32. **Cyprinodon latifasciatus.** *
33. **Adinia multifasciata.** ‡
34. **Fundulus similis.** ‡
35. **Fundulus zebrinus.** ‡
36. **Fundulus heteroclitus grandis.** ‡
37. **Lucania venusta.** ‡
38. **Gambusia affinis.** ‡
39. **Mollienesia latipinna.** ‡
40. **Pœcilia couchiana.** *
41. **Lepomis pallidus.** ‡
42. **Lepomis heros.** ‡
43. **Micropterus salmoides.** ‡
44. **Etheostoma fasciatus.** *
45. **Etheostoma lepidum.** ‡
46. **Etheostoma micropterus.** *
47. **Etheostoma australe.** *
48. **Etheostoma laterale.** †
49. **Aplodinotus grunniens.** ‡
50. **Heros cyanoguttatus.** †
51. **Heros pavonaceus.** *
52. **Gobiomorus dormitator.** †
53. **Dormitator maculatus.** †
54. **Gobius lyricus.** ‡

FISHES KNOWN ONLY FROM TEXAS AND THE RIO GRANDE BASIN.

The following 64 species (28 per cent) are thus far known only from the waters of Texas or the Rio Grande basin:

1. **Ameiurus nebulosus catulus.**
2. **Ameiurus natalis bolli.**
3. **Ameiurus lupus.**
4. **Carpiodes velifer tumidus.**
5. **Pantosteus plebeius.**
6. **Moxostoma congestum.**
7. **Campostoma ornatum.**
8. **Campostoma formosulum.**
9. **Zophendum plumbeum.**
10. **Dionda melanops.**
11. **Dionda punctifer.**
12. **Dionda fluviatilis.**
13. **Dionda amara.**
14. **Dionda episcopa.**
15. **Dionda serena.**
16. **Pimephales promelas confertus.**
17. **Cochlognathus ornatus.**
18. **Notropis cayuga atrocaudalis.**
19. **Notropis nitidus.**
20. **Notropis nux.**
21. **Notropis nocomis.**
22. **Notropis simus.**
23. **Notropis ornatus.**
24. **Notropis chihuahua.**
25. **Notropis leoninus.**
26. **Notropis proserpina.**
27. **Notropis formosus.**
28. **Notropis bubalinus.**
29. **Notropis lepidus.**
30. **Notropis garmani.**
31. **Notropis macrostomus.**
32. **Notropis [illegible].**
33. **Notropis notatus.**
34. **Notropis texanus.**
35. **Notropis amabilis.**
36. **Notropis socius.**
37. **Notropis [illegible].**
38. **Notropis fumeus.**
39. **Notropis notemigonoides.**
40. **Agosia oscula.**
41. **Agosia [illegible].**
42. **Hybopsis æstivalis marconis.**
43. **Stypodon signifer.**
44. **Leuciscus nigrescens.**
45. **Leuciscus conspersus.**
46. **Opsopœodus oscula.**
47. **Tetragonopterus argentatus.**
48. **Salmo mykiss spilurus.**
49. **Cyprinodon latifasciatus.**
50. **Fundulus pallidus.**
51. **Zygonectes funduloides.**
52. **Zygonectes pulvereus.**
53. **Zygonectes jenkinsi.**
54. **Pœcilia couchiana.**
55. **Lepomis albulus.**
56. **Etheostoma phlox.**
57. **Etheostoma fasciatum.**
58. **Etheostoma lepidogenys.**
59. **Etheostoma micropterus.**
60. **Etheostoma australe.**
61. **Etheostoma laterale.**
62. **Etheostoma fonticola.**
63. **Heros cyanoguttatus.**
64. **Heros pavonaceus.**

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* Catalogue of the Fresh-water Fishes of Central America and Southern Mexico. < Proc. U. S. Nat. Mus. 1893, 53-60.

The following 86 species (37 per cent) have been reported from only one locality in this region.

Species.	Locality from which reported.	Species.	Locality from which reported.
1. Carcharhinus platyodon	Galveston.	43. Selene vomer	Matamoras.
2. Pristis pectinatus	Do.	44. Lepomis symmetricus	Kilper's Pond, Houston.
3. Dasabatis sayi	Corpus Christi.	45. Lepomis albulus	Rio Blanco.
4. Trigon sabina	Galveston.	46. Etheostoma vivax	Sabine River at Longview.
5. Aëtobatis freminvillei	Do.	47. Etheostoma phlox	Trinity River at Ft. Worth.
6. Ameiurus natalis bolli	Little Wichita River.	48. Etheostoma shumardi	Red River at Fulton.
7. Carpiodes velifer	Red River at Fulton, Ark.	49. Etheostoma fasciatus	Chihuahua River.
8. Catostomus teres	Brownsville.	50. Etheostoma lepidogenys	Comal Springs, New Braunfels.
9. Moxostoma pœcilurum	Sabine River at Longview.	51. Etheostoma micropterus	Chihuahua, Mexico.
10. Campostoma ornatum	Chihuahua River.	52. Etheostoma australe	Rio de las Conchas.
11. Dionda punctifer	Spring near Saltilla.	53. Etheostoma jessiæ	Sabine River at Longview.
12. Dionda fluviatilis	Near Monterey, New Leon.	54. Etheostoma lateralis	Mouth of Rio Grande.
13. Notropis nitidus	Cadereita, New Leon	55. Roccus chrysops	Red River at Fulton.
14. Notropis sabinæ	Sabine River at Longview.	56. Rhomboplites aurorubens	Brazos Santiago.
15. Notropis simus	San Ildefonso, N. Mex.	57. Stelliferus lanceolatus	St. Joseph Island.
16. Notropis ornatus	Chihuahua River.	58. Larimus fasciatus	Galveston.
17. Notropis chihuahua	Do.	59. Menticirrhus littoralis	Do.
18. Notropis formosus	Rio Mimbres, Chihuahua.	60. Cynoscion nothus	Brazos Santiago.
19. Notropis lepidus	Rio Frio.	61. Heros pavonaceus	Mondova, Coahuila.
20. Notropis garmani	Lago del Muerte.	62. Chætodipterus faber	Galveston.
21. Notropis amabilis	Rio Leona.	63. Gobiomorus dormitator	Mouth of Rio Grande.
22. Notropis fumeus	Hunter Creek near Houston.	64. Gobius soporator	St. Joseph Island.
23. Agosia yarrowi	Rio Grande, Colorado.	65. Gobius würdemanni	Brazos Santiago.
24. Hybopsis storerianus	Red River at Fulton.	66. Gobionellus oceanicus	St. Joseph Island.
25. Stypodon signifer	Parras, Coahuila.	67. Prionotus scitulus	Galveston.
26. Hiodon alosoides	Red River at Fulton.	68. Gobiesox virgatulus	Do.
27. Megalops atlanticus	Galveston.	69. Porichthys porosissimus	Do.
28. Opisthonema thrissa	Do.	70. Upsilonphorus y-græcum	Do.
29. Stolephorus browni	Do.	71. Astroscopus anoplos	Do.
30. Cyprinodon latifasciatus.	Parras, Coahuila.	72. Chasmodes bosquianus	Corpus Christi.
31. Fundulus pallidus	Galveston Bay.	73. Isesthes hentzi	Do.
32. Fundulus diaphanus	Comanche Creek, Mason Co.	74. Isesthes ionthas	Galveston.
33. Zygonectes funduloides	Dickinson Bayou.	75. Isesthes scrutator	Do.
34. Zygonectes escambiæ	Trinity River, Magnolia Point.	76. Hypleurochilus geminatus	St. Joseph Island.
35. Gymnothorax ocellatus nigromarginatus.	St. Joseph Island.	77. Ophidion marginatum	Do.
36. Neoconger mucronatus	Do.	78. Citharichthys spilopterus	Galveston.
37. Hemirhamphus unifasciatus.	Galveston.	79. Etropus crossotus	Do.
38. Siphostoma floridæ	Corpus Christi.	80. Ancylopsetta quadrocellata.	Do.
39. Siphostoma fuscum	Do.	81. Pterophryne histrio	Do.
40. Labidesthes sicculus	Long Lake, Magnolia Point.	82. Malthe vespertilio	Do.
41. Menidia vagrans	Galveston,	83. Ostracion tricorne	Do.
42. Caranx hippos	Mouth of Rio Grande.	84. Aluter schœpfii	Do.
		85. Lagocephalus lævigatus	Do.
		86. Chilomycterus schœpfii	Do.

SPECIES FOUND IN BOTH THE WABASH RIVER AND RIO GRANDE BASINS.

A comparison of the fish faunas of two such important and widely separated river basins as the Wabash and the Rio Grande is not without interest. The total number of fishes known from the Rio Grande basin is 80, while the number now known from the Wabash basin is 130. Of the 80 species from the Rio Grande basin 11 are brackish-water species, thus leaving only 69 true fresh-water species found in the Rio Grande basin, which is only about one-half as many as found in the Wabash basin. So far as known, only 23 species are common to both of these river basins. Of these there are 4 catfishes, 3 suckers, 4 minnows, and 5 sunfishes. Nearly all are fishes of lowland streams and ponds, and are species of wide distribution in the eastern and southeastern United States.

1. Scaphirhynchus platyrhynchus.
2. Lepisosteus osseus.
3. Lepisosteus platystomus.
4. Leptops olivaris.
5. Ameiurus natalis.
6. Ictalurus punctatus.
7. Ictalurus furcatus.
8. Catostomus teres?
9. Erimyzon sucetta.
10. Minytrema melanops.
11. Campostoma anomalum.
12. Hybognathus nuchalis.
13. Notropis dilectus.
14. Notemigonus chrysoleucus.
15. Fundulus diaphanus.
16. Gambusia affinis.
17. Anguilla chrysypa.
18. Lepomis cyanellus.
19. Lepomis megalotis.
20. Lepomis pallidus.
21. Lepomis heros.
22. Micropterus salmoides.
23. Aplodinotus grunniens.

GEOGRAPHICAL DISTRIBUTION OF FISHES IN TEXAS AND THE RIO GRANDE REGION.

The following table shows our present knowledge of the geographic distribution of fishes in the principal river basins of Texas and the Rio Grande region:

Geographical distribution of fishes in the principal river basins of Texas and the Rio Grande Region.

	Species.	Arkansas River Basin.	Red River Basin.	Sabine River Basin.	Neches River Basin.	Trinity River Basin.	San Jacinto River and Buffalo and Dickinson Bayous.	Brazos River Basin.	Colorado River Basin.	San Antonio River Basin.	Nueces River Basin.	Rio Grande Basin.	Galveston.	Corpus Christi.	Indianola.	Brazos Santiago.	St. Joseph Island.
1	Carcharhinus platyodon												×				
2	Pristis pectinatus												×				
3	Dasabatis sayi													×			
4	Trigon sabina												×				
5	Aëtobatis fréminvillei												×				
6	Scaphirhynchus platyrhynchus		×									×					
7	Lepisosteus osseus		×					×		×		×					
8	Lepisosteus platystomus						×					×					
9	Lepisosteus tristœchus											×					
10	Noturus nocturnus	×		×		×	×	×		×							
11	Leptops olivaris		×			×		×	×	×		×					
12	Ameiurus melas	×			×	×				×							
13	Ameiurus nebulosus catulus	×							×	×							
14	Ameiurus natalis	×					×	×		×		×					
15	Ameiurus natalis bolli		×														
16	Ameiurus lupus									×	×	×					
17	Ictalurus punctatus		×		×	×	×	×	×	×	×	×					
18	Ictalurus furcatus					×	×					×					
19	Tachysurus felis												×	×	×		
20	Felichthys marinus												×		×		
21	Ictiobus cyprinella						×										
22	Ictiobus bubalus		×			×											
23	Carpiodes carpio					×			×								
24	Carpiodes velifer		×														
25	Carpiodes velifer tumidus							×	×			×					
26	Pantostens plebeius											×					
27	Catostomus teres											×					
28	Erimyzon sucetta	×			×					×		×					
29	Minytrema melanops				×	×				×							
30	Moxostoma pœcilurum			×													
31	Moxostoma congestum							×	×	×		×					
32	Campostoma ornatum											×					
33	Campostoma anomalum					×		×	×	×		×					
34	Campostoma formosulum									×		×					
35	Zophendum plumbeum	×															
36	Dionda melanops											×					
37	Dionda punctifer											×					
38	Dionda fluviatilis											×					
39	Dionda amara											×					
40	Dionda episcopa								×	×	×	×					
41	Dionda serena									×	×	×					
42	Hybognathus nuchalis	×	×	×	×	×	×					×					
43	Pimephales promelas confertus	×										×					
44	Pimephales notatus		×						×								
45	Cochlognathus ornatus					×						×					
46	Cliola vigilax		×	×	×	×	×	×	×	×							
47	Notropis cayuga atrocaudalis						×	×		×							
48	Notropis nitidus											×					
49	Notropis nux				×	×											
50	Notropis deliciosus	×					×	×		×		×					
51	Notropis sabinæ			×													
52	Notropis nocomis					×				×							
53	Notropis simus											×					
54	Notropis ornatus											×					
55	Notropis chihuahua											×					
56	Notropis leoninus									×	×	×					
57	Notropis lutrensis	×	×	×	×	×		×	×	×		×					
58	Notropis proserpina											×					

Geographic distribution of fishes in principal river basins of Texas and the Rio Grande region—Continued.

	Species.	Arkansas River Basin.	Red River Basin	Sabine River Basin.	Neches River Basin.	Trinity River Basin.	San Jacinto River and Buffalo and Dickinson Bayous.	Brazos River Basin.	Colorado River Basin.	San Antonio River Basin.	Nueces River Basin.	Rio Grande Basin.	Galveston.	Corpus Christi.	Indianola.	Brazos Santiago.	St. Joseph Island.
59	Notropis formosa											×					
60	Notropis bubalinus	×	×									×					
61	Notropis lepidus										×						
62	Notropis garmani											×					
63	Notropis macrostomus									×		×					
64	Notropis venustus		×	×	×	×	×	×	×		×						
65	Notropis notatus								×		×						
66	Notropis texanus				×			×		×	×						
67	Notropis amabilis										×						
68	Notropis socius											×					
69	Notropis swaini								×	×		×					
70	Notropis umbratilis	×	×														
71	Notropis dilectus	×	×	×	×	×						×					
72	Notropis fumeus						×										
73	Notropis notemigonoides				×		×										
74	Phenacobius mirabilis			×		×						×					
75	Rhinichthys dulcis											×					
76	Agosia oscula											×					
77	Agosia yarrowi											×					
78	Hybopsis storerianus		×														
79	Hybopsis æstivalis		×						×			×					
80	Hybopsis æstivalis marconis									×							
81	Semotilus atromaculatus	×	×														
82	Stypodon signifer											×					
83	Leuciscus nigrescens											×					
84	Leuciscus conspersus											×					
85	Opsopœodus oscula				×	×	×										
86	Notemigonus chrysoleucus	×			×	×	×			×	×	×					
87	Tetragonopterus argentatus										×	×					
88	Hiodon alosoides		×														
89	Megalops atlanticus												×				
90	Clupea chrysochloris		×										×				
91	Harengula arcuata												×	×			
92	Opisthonema thrissa												×				
93	Brevoortia tyrannus patronus												×			×	
94	Dorosoma cepedianum		×			×	×			×			×				
95	Stolephorus browni												×				
96	Stolephorus mitchilli						×						×	×			
97	Synodus fœtens												×				
98	Salmo mykiss spilurus											×					
99	Cyprinodon variegatus						×					×	×	×	×		
100	Cyprinodon latifasciatus											×					
101	Cyprinodon elegans											×					
102	Adinia multifasciata											×	×		×		×
103	Fundulus pallidus												×				
104	Fundulus similis											×	×	×	×		
105	Fundulus zebrinus	×											×				
106	Fundulus diaphanus								×								
107	Fundulus heteroclitus grandis						×					×	×	×	×		
108	Zygonectes funduloides						×										
109	Zygonectes pulvereus						×							×			
110	Zygonectes jenkinsi						×						×				
111	Zygonectes notatus		×	×	×	×	×	×		×							
112	Zygonectes escambiæ					×											
113	Lucania venusta											×			×		
114	Lucania parva						×			×				×			
115	Gambusia affinis		×	×	×	×	×	×	×	×	×	×	×				
116	Mollienesia latipinna						×					×	×	×	×		
117	Pœcilia couchiana											×					
118	Lucius vermiculatus				×	×											
119	Gymnothorax ocellatus nigromarginatus																×
120	Myrophis punctatus												×	×			
121	Neoconger mucronatus																×
122	Anguilla chrysypa								×	×		×					
123	Tylosurus longirostris												×			×	×
124	Hemirhamphus unifasciatus												×				
125	Siphostoma floridæ													×			
126	Siphostoma louisianæ						×						×	×			
127	Siphostoma fuscum													×			

Geographic distribution of fishes in principal river basins of Texas and the Rio Grande region—Continued.

	Species.	Arkansas River Basin.	Red River Basin.	Sabine River Basin.	Neches River Basin.	Trinity River Basin.	San Jacinto River and Buffalo and Dickinson Bayous.	Brazos River Basin.	Colorado River Basin.	San Antonio River Basin.	Nueces River Basin.	Rio Grande Basin.	Galveston.	Corpus Christi.	Indianola.	Brazos Santiago.	St. Joseph Island.
128	Mugil cephalus												×	×	×	×	×
129	Labidesthes sicculus					×											
130	Menidia vagrans												×				
131	Menidia peninsulæ						×						×	×			
132	Polynemus octonemus												×			×	
133	Trichiurus lepturus												×			×	×
134	Caranx hippos											×				×	
135	Vomer setipinnis												×			×	
136	Selene vomer											×					
137	Chloroscombrus chrysurus												×	×			×
138	Trachynotus carolinus												×				×
139	Oligoplites saurus						×						×	×			×
140	Aphredoderus sayanus				×		×										
141	Pomoxis annularis				×	×	×										
142	Pomoxis sparoides		×				×										
143	Chænobryttus gulosus				\	×	×	×		×							
144	Lepomis cyanellus	×	×			×		×	×	×	×	×					
145	Lepomis symmetricus						×										
146	Lepomis miniatus						×			×							
147	Lepomis megalotis		×		×	×	×	×	×	×	×	×					
148	Lepomis humilis			×		×		×									
149	Lepomis pallidus	×	×		×	×	×	×	×	×	×	×					
150	Lepomis heros						×			×	×	×					
151	Lepomis albulus									×							
152	Micropterus salmoides		×	×	×	×	×	×	×	×	×	×					
153	Etheostoma pellucidum clarum		×	×													
154	Etheostoma vivax			×													
155	Etheostoma phlox					×											
156	Etheostoma chlorosoma				×		×										
157	Etheostoma shumardi		×														
158	Etheostoma caprodes					×			×	×							
159	Etheostoma fasciatus											×					
160	Etheostoma sciérum serrula			×	×	×	×	×		×							
161	Etheostoma lepidum							×	×	×	×	×					
162	Etheostoma lepidogenys									×							
163	Etheostoma micropterus											×					
164	Etheostoma australe											×					
165	Etheostoma jessiæ			×													
166	Etheostoma fusiforme				×	×	×				×						
167	Etheostoma lateralis											×					
168	Etheostoma fonticola						×			×							
169	Centropomus undecimalis												×	×			
170	Roccus chrysops		×														
171	Morone interrupta					×	×										
172	Lutjanus caxis															×	
173	Lutjanus aya												×				
174	Rhomboplites aurorubens															×	
175	Orthopristis chrysopterus												×	×	×	×	
176	Lagodon rhomboides												×	×	×	×	×
177	Archosargus probatocephalus												×	×	×	×	
178	Aplodinotus grunniens		×			×			×			×					
179	Pogonias chromis												×			×	
180	Stelliferus lanceolatus																×
181	Bairdiella chrysura												×	×			
182	Sciæna ocellata						×						×	×	×		
183	Leiostomus xanthurus												×	×	×	×	×
184	Larimus fasciatus												×				
185	Micropogon undulatus											×	×		×		×
186	Menticirrhus littoralis												×				
187	Menticirrhus americanus												×		×	×	
188	Cynoscion nothus															×	
189	Cynoscion nebulosus						×						×	×	×	×	
190	Gerres gula													×	×	×	×
191	Gerres gracilis						×						×	×			
192	Heros cyanoguttatus											×					
193	Heros pavonaceus											×					
194	Chætodipterus faber												×				
195	Gobiomorus dormitator															×	

Geographic distribution of fishes in principal river basins of Texas and the Rio Grande region—Continued.

	Species.	Arkansas River Basin.	Red River Basin.	Sabine River Basin.	Neches River Basin.	Trinity River Basin.	San Jacinto River and Buffalo and Dickinson Bayous.	Brazos River Basin.	Colorado River Basin.	San Antonio River Basin.	Nueces River Basin.	Rio Grande Basin.	Galveston.	Corpus Christi.	Indianola.	Brazos Santiago.	St. Joseph Island.
196	Dormitator maculatus												×			×	
197	Gobius lyricus											×	×			×	
198	Gobius soporator																×
199	Gobius boleosoma						×						×	×			
200	Gobius würdemanni															×	
201	Gobionellus oceanicus																×
202	Lepidogobius gulosus						×							×	×		
203	Gobiosoma bosci												×	×			
204	Gobiosoma molestum													×	×		
205	Prionotus scitulus												×				
206	Prionotus tribulus												×	×			
207	Gobiesox virgatulus												×				
208	Batrachus tau													×	×		
209	Porichthys porosissimus												×				
210	Upsilonphorus y-græcum												×				
211	Astroscopus anoplos												×				
212	Chasmodes bosquianus													×			
213	Isesthes hentzi													×			
214	Isesthes ionthas												×				
215	Isesthes scrutator												×				
216	Hypleurochilus geminatus																×
217	Ophidion marginatum																×
218	Citharichthys spilopterus												×				
219	Etropus crossotus												×				
220	Paralichthys lethostigma						×						×	×			
221	Ancylopsetta quadrocellata												×				
222	Achirus fasciatus						×						×				
223	Symphurus plagiusa						×						×	×			
224	Pterophryne histrio												×				
225	Malthe vespertilio												×				
226	Ostracion tricorne												×				
227	Alutera schœpffi												×				
228	Lagocephalus lævigatus												×				
229	Tetrodon nephelus												×	×			
230	Chilomycterus schœpffi												×				
	Totals	18	32	17	26	39	52	24	25	44	20	80	78	39	21	22	18

LIST OF FISHES KNOWN FROM TEXAS AND THE BASIN OF THE RIO GRANDE.

In the following pages we give a list of all the species so far known to occur in this region. In connection with each species are given all the Texas and Rio Grande localities from which it has been recorded, together with the name of the writer so recording it and the year in which the paper was published. Whenever the name under which it was recorded is not that which is now accepted as the tenable name for the species, it is given in parenthesis, with the authority for it. New species are indicated by the word *type* in connection with its specific name. Locality references have usually been given in the exact words of the original authority; when the exact words have not been used, the change made has not been such as to change the sense in the least. The types of most of these species (such as are described from that region) are in the U. S. National Museum. These have all been examined by us, and the species recognized in this paper are such as appear to us to be valid after having not only studied all the types available, but practically all the collections from that region now in the National Museum. A number of Girard's types can not now be found, and our identification of some of those species may be erroneous.

With regard to its fresh-water fishes, Texas is chiefly remarkable for the abundance of species in its lowland streams. A large proportion of its species are confined chiefly or almost wholly to the streams of the narrow strip known as the Coast Plain region. The lower portions of the larger streams crossing this teem with many species of valued food-fishes, such as the channel cat, chuckle-headed cat, mud cat, buffalo, large-mouthed black bass (the "trout" of the South), various species of sunfishes, and the fresh-water drum. The amount of fish of these kinds brought to the Houston market, principally from the San Jacinto and Trinity, is very great, and these, together with the salt-water species received from and about the mouth of these rivers, make the Houston fish-market one of the most important in the South. The coast of Texas is also remarkable for the number of brackish-water species, the single family of *Cyprinodontidæ* being represented by at least 19 species, most of which are found only near the coast. Of the 230 species of fishes given in this paper, 46 were added to the known Texas fauna through the explorations of Jordan and Gilbert, and 42 were added by our own investigations in 1891. With few exceptions, the remaining species were first collected in this region during the Mexican Boundary and Pacific Railroad surveys.

I.—GALEORHINIDÆ. THE TYPICAL SHARKS.

1. **Carcharhinus platyodon** (Poey). *Shovel-nosed Shark.* Galveston (Jordan & Gilbert, 1882). This is said to be the commonest of the large sharks on the coast of Texas in summer. The jaws of another species of *Carcharhinus* were gotten by Dr. Jordan at Galveston, which has not yet been identified with certainty.

II.—PRISTIDIDÆ. THE SAWFISHES.

2. **Pristis pectinatus** Latham. *Sawfish.* Obtained by Dr. Jordan at Galveston.

III.—DASYATIDÆ. THE STINGRAYS.

3. **Dasabatis sayi** (Le Sueur). *Southern Stingray; Whipparee; Whipray.* Two young specimens were obtained by me at Shamrock Point, Corpus Christi, November 28.
4. **Trigon sabina** (Le S.). *Stingray; Stingaree.* Galveston (Jordan & Gilbert, 1882).

IV.—AËTOBATIDÆ. THE EAGLE RAYS.

5. **Aëtobatis freminvillei** (Le S.). *Eagle Ray.* A tail 5½ feet long, obtained at Galveston, evidently of this species.

V.—ACIPENSERIDÆ. THE STURGEONS.

6. **Scaphirhynchus platyrhynchus** (Rafinesque). *Shovel-nosed Sturgeon.* Reported from Red River at Fulton, Ark., by Jordan & Gilbert, and by Cope & Yarrow from the Rio Grande, near Albuquerque, N. Mex., where two specimens were obtained by Dr. Oscar Loew.

VI.—LEPISOSTEIDÆ. THE GARFISHES.

7. **Lepisosteus osseus** (Linnæus). *Long-nosed Gar.* Taken by Jordan & Gilbert in Red River at Fulton, Ark., the Rio Lampasas at Belton, Tex., and the Rio San Marcos at San Marcos, Tex. Rio Grande (Synopsis).
8. **Lepisosteus platystomus** Raf. *Short-nosed Gar.* Specimens were taken in the Pecos River by the Pacific Railroad Survey, which are the types of Girard's *Lepidosteus* (*Cylindrosteus*) *latirostris* (Girard, 1858). One specimen, 14 inches long, was taken by us in Dickinson Bayou, near Nicholstone, Tex.
9. **Lepisosteus tristœchus** (Bloch & Schneider). *Alligator Gar.* This species has been recorded from Tamaulipas, Mexico, and from Devil River, Tex., the first locality furnishing the type of Girard's *Lepidosteus* (*Atractosteus*) *berlandieri* (Girard, 1858), while his type of *Lepidosteus leptorhynchus* (Girard, 1858) came from the latter place.

VII.—SILURIDÆ. THE CATFISHES.

10. **Noturus nocturnus** Jordan & Gilbert. During the explorations of Professors Jordan and Gilbert in the Southwest, in 1884, the types of this catfish were obtained in the Poteau River, near Fort Smith, Ark. They also found it in the Rio Lampasas at Belton, Tex., the Sabine River at Longview, Tex., and in Trinity River at Dallas. I obtained 8 specimens in San Antonio Springs, at San Antonio, and 2 from Hunter Creek, near Houston.
11. **Leptops olivaris** (Raf.). "*Yellow Cat*"; "*Mud Cat.*" Trinity River at Dallas and Fort Worth (Cope, 1880). Rio Colorado at Austin, Trinity River at Dallas, Rio Lampasas at Belton, and Red River at Fulton (Jordan & Gilbert, 1886). One specimen from the Trinity River at Magnolia Point and one from San Antonio Springs. Many large fish of this species were seen in the Houston market, where it is an important and valuable food-fish. They are caught in considerable numbers in the Trinity River, near its mouth, and sent to the Houston market. This species was collected also by Mr. A. J. Woolman at Juarez, Mexico, in 1891.
12. **Ameiurus melas** (Raf.). Wallace Creek, one of the heads of Medina River, in Bandera County, (as *Amiurus brachyacanthus* types, Cope, 1880, and Synopsis). Long Lake and Trinity River near Magnolia Point, and Neches River near Palestine. Spring Creek and Fulton Creek near Creswell (Coate).
13. **Ameiurus nebulosus catulus** (Girard). This variety, the distinctness of which from *nebulosus* is not easy to recognize, was described by Dr. Girard in the Pacific Railroad Report from specimens obtained at Fort Smith, Arkansas. It has also been found in the Little Wichita River (as *Amiurus catus*, Cope, 1880), in the Rio Colorado at Austin and Rio San Marcos at San Marcos (Jordan & Gilbert, 1886), and by us in the Rio San Marcos at San Marcos, Comal Springs at New Braunfels, and in San Antonio Springs at San Antonio. At San Marcos and New Braunfels it is quite numerous.
14. **Ameiurus natalis** (Le S.). Near San Antonio (as *Pimelodus antoniensis* types, Girard, 1858). Tributary of Gypsum Creek, of the Canadian River (as *Pimelodus felinus* types, Girard, 1858). Brownsville (Jordan, 1878), and Sims Bayou near Houston. San Antonio, Tex. (as *Noturus flavus*, Garman, 1881a). In the National Museum is a small specimen, 2¾ inches long, labeled *Amiurus natalis antoniensis* (type?). It is from Leon River, and was collected by Dr. Kennerly. Anal 24, 3½ in length of body to base of caudal fin.

15. **Ameiurus natalis bolli** Cope. This subspecies was described by Cope in 1880, from specimens obtained in the Little Wichita, northern Texas. (Synopsis.)

16. **Ameiurus lupus** (Grd.). Indianola to Nueces and headwaters of Rio Pecos (and as *Pimelodus lupus* types, Girard, 1856 and 1858); and a tributary of the Medina River (Cope, 1880). The one specimen in the Museum marked as the type of this species (No. 916) is a young fish 10 inches long and in good condition. Anal, 22; tail forked; pectoral spine as long as from point of snout to pupil, or 2½ in head; upper jaw considerably projecting.

17. **Ictalurus punctatus** (Raf.). *Channel Cat; "Eel Cat"* of Houston Market. Live Oak Creek, Comanche Springs, Rio Leona, Nueces, Piedra Painte, Devil River, and Rio Salado (as *Pimelodus vulpes* types, Girard, 1859, pl. XVIII). Trinity River at Fort Worth and Dallas, Little Wichita River (as *Ichthælus cœrulescens*, Cope, 1880). Rio Colorado at Austin, Rio Lampasas at Belton, and Red River at Fulton, Ark. (Jordan & Gilbert, 1886). Rio San Marcos at San Marcos, Trinity River at Magnolia Point, Neches River near Palestine, San Antonio Springs at San Antonio, Trinity River at its mouth, and San Jacinto River at Lynchburg; from these places considerable quantities of this fish reach the Houston market, where it is held in high esteem, Also collected by Mr. Woolman in 1891 at Juarez, opposite El Paso, Tex. In the National Museum we find only one bottle of the types of *Pimelodus vulpes;* these are four very young specimens (No. 845) from the Leon River, collected by J. H. Clark. They are in fair condition and agree fully with the young of *Ictalurus punctatus.*

18. **Ictalurus furcatus** (Cuvier & Valenciennes). *"Channel Cat"* or *"Blue Cat"* of the Houston market. Mouth of Rio Grande near Brownsville (as *Pimelodus affinis* types, Baird & Girard, 1854, and Girard, 1859, pls. XVI and XVII). Trinity River near its mouth and San Jacinto River at Lynchburg. This is one of the most important fresh-water fishes of the Houston market, but it is not regarded as being as good a fish as the preceding. The largest individual of *I. furcatus* that I saw weighed 44 pounds; another weighed 25 pounds. The Houston market receives these fish from the lower Trinity and San Jacinto rivers.

19. **Tachysurus felis** (L.). Indianola (as *Arius equestris* types, Baird & Girard, 1854, and Girard, 1859, pl. XV). Galveston (Jordan & Gilbert, 1882). Galveston and Corpus Christi. It does not appear to be a very common fish on the Texas coast, as we obtained only two specimens at Galveston and one at Corpus Christi. Maxillary barbel longer than head, reaching a little beyond base of pectoral on the specimen from Corpus Christi and two-thirds the length of the pectoral spine in those from Galveston.

20. **Felichthys marinus** (Mitchill). *Salt-water Catfish.* Indianola (Baird & Girard, 1854, and Girard, 1859, pl. XIV). Galveston (Jordan & Gilbert, 1882). These are the only Texas references to this species.

VIII.—CATOSTOMIDAE. THE SUCKERS.

21. **Ictiobus cyprinella** (C. & V.). Three specimens of this species were obtained in Dickinson Bayou at Nicholstone, and numerous large individuals from San Jacinto River near Lynchburg were seen in the fish market at Houston.

22. **Ictiobus bubalus** (Raf.). Red River at Fulton, Ark. (Jordan & Gilbert, 1886). We have one specimen from near the mouth of Trinity River, which we obtained in the Houston market.

23. **Carpiodes carpio** (Raf.). Rio Colorado at Austin (Jordan & Gilbert, 1886). Our collection contains one specimen from Long Lake near Magnolia Point.

24. **Carpiodes velifer** (Raf.). The only record of this species from the region covered by this paper is that given by Jordan & Gilbert for the Red River at Fulton, Ark.

25. **Carpiodes velifer tumidus** B. & G. Near Fort Brown (as *Carpiodes tumidus* types, Baird & Girard, 1854, and Girard, 1859, pl. XIX, figs. 1-4). Rio Grande (as *Ictiobus tumidus*, Girard, 1856). Several specimens from San Ildefonso, N. Mex. (as *Carpiodes grayi* types, Cope, 1870, and Cope & Yarrow, 1875). Brownsville (Jordan, 1878). Nazas River at San Pedro, Coahuila (as *Ichthyobus tumidus*, Garman, 1881). Rio Grande (Synopsis). Rio Lampasas at Belton and Rio Colorado at Austin (Jordan & Gilbert, 1886). Cope's types of *Carpiodes grayi* consist of 7 small specimens (U. S. N. M. No. 16761), 6 of which are less than 2 inches long, the other being about 4½ inches. They are in very poor condition.

26. Pantosteus plebeius (B. & G.). The types of this sucker were collected by Mr. John H. Clark in the Rio Mimbres, Chihuahua (as *Catostomus plebeius* types, Baird & Girard, 1854). Rio Mimbres, Lake Guzman, Mexico (as *Minomus plebeius*, Girard, 1856, and Girard, 1859, pl. XXII, figs. 1–4). Janos River, a tributary of Lake Guzman, Chihuahua (as *Catostomus* (*Acomus*) *guzmaniensis* types, Girard, 1856, and Girard, 1859, pl. XXIII, figs. 6–10). Lake Guzman (Synopsis). Nazas River, Coahuila (as *Catostomus nebuliferus* types, Garman, 1881, and Synopsis). Rio Grande at Del Norte and Alamosa, Colo., and the Rio Conejos near Alamosa, Colo. (Jordan, 1891); Rio Mimbres and Rio Janos, Lake Guzman, Chihuahua; Rio Grande, Ildefonso; Ojo de Gallo, N. Mex. (?); Rio Grande and Rio Conejos, Alamosa, Colo. (Evermann, 1893). There are in the Museum 2 specimens (No. 260) labeled as the types of *Acomus guzmaniensis;* they are 4½ and 5 inches long, respectively, and are pretty soft; lower lip broad and considerably incised; fontanelle entirely obliterated; cartilaginous sheath of lips less sharp than in *Pantosteus jordani*.

27. Catostomus teres (Mitchill). *Common White Sucker*. Nc. 20057, National Museum, is a fish of this species, 8 inches long. The locality given on the label is Brownsville, Tex. The name of the collector is not given, and it is not certain the specimen came from the alleged locality. Head, 4¼; D. I, 12; A. I, 7; eye, 5; scales, 62.

28. Erimyzon sucetta (Lac.). Dry Creek near Victoria (as *Moxostoma kennerlii* types, Girard, 1856 and 1859, pl. XX, figs. 7–9). Devil River and Live Oak Creek (as *Moxostoma campbelli* types, Girard, 1856 and 1859, pl. XX, figs. 4–6). Coal Creek, a tributary of South Fork of Canadian River (as *Moxostoma claviformis* types, Girard, 1856, and Girard, 1858, pl. XLVIII, figs. 5–9). The types of *Moxostoma claviformis* (U. S. N. M. No. 165) are 2 specimens 3 and 3¼ inches long; they are in poor condition, but are evidently this species. The types of *Moxostoma kennerlii* consist of 8 specimens, 2¼ to 6 inches long (U. S. N. M. No. 161); they are faded and very soft; scales 36. We obtained 5 specimens from a pond near the Neches River, 14 miles east of Palestine.

29. Minytrema melanops (Raf.). Dry Creek near Victoria (as *Moxostoma victoriæ* types, Girard, 1856, and Girard, 1859, pl. XX, figs. 1–3). Obtained by us in Long Lake and Trinity River near Magnolia Point, Neches River east of Palestine, and Guadalupe River near New Braunfels.

30. Moxostoma congestum (B. & G.). Rio Salado (as *Catostomus congestus* types, Baird & Girard, 1854). Rio Salado (as *Ptychostomus congestus*, Girard, 1856, and Girard, 1859, pl. XXI, figs. 5–8). Rio San Juan near Monterey, New Leon (as *Ptychostomus albidus* types, Girard, 1856, and Girard, 1859, pl. XIX, figs. 5–8). Guadalupe and Llano rivers (as *Myxostoma macrolepidotum duquesnei*, Cope, 1880). Rio Lampasas at Belton, Rio Colorado at Austin, and Rio San Marcos at San Marcos (Jordan & Gilbert, 1886). Two large specimens were obtained by us in the outlet of San Antonio Springs at San Antonio. The types of *Ptychostomus albidus* are 2 specimens 4 to 6 inches long (U. S. N. M. No. 170), and are in poor condition.

31. Moxostoma pœcilurum Jordan. Sabine River at Longview (Jordan & Gilbert, 1886).

IX.—CYPRINIDÆ. THE MINNOWS.

32. Campostoma ornatum Grd. Chihuahua River and a tributary only a few miles long (type, Girard, 1856, and Girard, 1859, pl. XXV, figs. 1–4). Chihuahua River (Synopsis). The type (U. S. N. M. No. 77) is about 5 inches long and is in fair condition. The dorsal fin is still quite black, having held its color remarkably well. There are about 82 scales in the lateral line.

33. Campostoma anomalum (Raf.). Cadereita and near Monterey, New Leon (as *Campostoma nasutum* types, Girard, 1856). Cadereita and Acapulco, New Leon (as *Campostoma nasutum*, Girard, 1859, pl. XXV, figs. 9–12). Helotes on the Upper Medina and Comanche Creek at Mason (as *Campostoma anomalum pullum*, Cope, 1880). Rio Lampasas at Belton, Rio Colorado at Austin, and Trinity River at Dallas (Jordan & Gilbert, 1886). We obtained one specimen in the Rio San Marcos near San Marcos.

34. Campostoma formosulum Grd. Rio Sabinal, a tributary of the Rio San Antonio (types, Girard, 1856, and Girard, 1859, pl. XXV, figs. 5–8). Brownsville (Jordan, 1878). San Antonio River (Synopsis). There are 16 specimens, 2¼ to 4 inches long (U. S. N. M. No. 76), recorded as the types of this species. The scales in the lateral line vary from 45 to 48, and thus appear to be a trifle larger than in *C. anomalum*, from which it does not seem to differ otherwise.

35. Zophendum plumbeum (Grd.). Headwaters of the Canadian River, Llano Estacado (as *Dionda plumbea* types, Girard, 1856, and Girard, 1858, pl. LII, figs. 21–25). Antelope Creek, a tributary of the Canadian River, and from the Llano Estacado (as *Hyborhynchus puniceus* types, Girard, 1856, and Girard, 1858, pl. LII, figs. 1–5 and 11–15). Twenty miles west of Choctaw Agency (as *Dionda grisea* types, Girard, 1858, pl. LII, figs. 6–10).

36. Dionda melanops Grd. Buena Vista, Coahuila (types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 17–20). Cuajuco, Monterey, and Cadereita, New Leon, in the waters of the Rio San Juan (as *Dionda couchi* types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 1–4). Brownsville (as *Hybognathus melanops*, Jordan, 1878). The five types of this species in the National Museum (No. 41) very much resemble *Dionda episcopa*, but differ from it in being a much shorter, deeper species. Head, 3¾; depth, 3¼; eye, 3½; scales, 7–39–4. These specimens are in good condition.

37. Dionda punctifer Garman. Parras, and spring near Saltillo, Coahuila (as *Hybognathus* (*Dionda*) *punctifer* type, Garman, 1881).

38. Dionda fluviatilis (Grd.). Near Monterey, New Leon (as *Algoma fluviatilis* type, Girard, 1856, and Girard, 1859, pl. XXVII, figs. 13–16).

39. Dionda amara (Grd.). Lagoon near Fort Brown, on the Rio Grande (as *Algoma amara* type, Girard, 1856, and Girard, 1859, pl. XXVII, figs. 17–20). Brownsville (as *Hybognathus amarus*, Jordan, 1878). The type of this species is a single specimen (U. S. N. M. No. 149), 2¼ inches long, now in very poor condition. Head, 4; eye, 3¼; D. I, 9; A. I, 8; scales, 6–35–3. Apparently a good species.

40. Dionda episcopa Grd. Headwaters of the Rio Pecos, and Comanche Spring, a presumed tributary of the Rio Grande (types, Girard, 1856). Headwaters of the Rio Pecos (Girard, 1858). Rio Nueces (as *Dionda texensis* types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 21–24). San Felipe Creek and Devil Creek, two tributaries of the Rio Grande (as *Dionda argentosa* types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 5–8). Johnson Fork of Llano River, Kimble County (as *Hybognathus flavipinnis* types, Cope, 1880). Llano River (Synopsis). Rio Comal, New Braunfels (Jordan & Gilbert, 1886). We obtained a single specimen of this species in the Comal Spring at New Braunfels, which agrees perfectly with the types. The latter consist of 13 specimens (U. S. N. M. No. 45), varying in length from 1¾ to 3¼ inches, most of which are in good condition. Several of the types examined give the following: Head, 4; depth, 4; eye, 3¼, =snout; D. I, 8; A. I, 7 or 8; scales, 6–38–4. The types of *Dionda argentosa*, 2 specimens, 2 and 3 inches long respectively (U. S. N. M. No. 32), give the following: Head, 4; depth, 4; eye, 3¼; D., I, 8; A., I, 7; scales, 6–38–4, thus agreeing fully with the types of *Dionda episcopa*. The color markings are also the same. In *Dionda amara* there is no trace of the plumbeous lateral band and the dark caudal spot to be seen in *Dionda episcopa*, but it is more silvery. In *Dionda serena* the band and spot are present, but very faint. Bottle No. 32, U. S. N. M., contains 12 specimens labeled as the types of *Dionda argentosa*; these are each about 2¼ inches in length and agree well with the types of *D. episcopa*; they are all in a good state of preservation.

41. Dionda serena Grd. Rio Sabinal (types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 9–12). Delaware Creek, a tributary of the Rio Pecos (as *Dionda papalis* types, Girard, 1856, and Girard, 1858). Live Oak Creek, a tributary of the Rio Pecos (as *Dionda chrysitis* types, Girard, 1856, and Girard, 1859, pl. XXVI, figs. 13–16). Brownsville (as *Hybognathus serenus*, Jordan, 1878). Upper waters of Wallace Creek, one of the heads of Medina River (as *Hybognathus nigrotæniata* types, Cope, 1880). Medina River (as *Hybognathus nigrotæniatus*, Synopsis). The types of *Dionda serena* are two specimens, 2 and 3 inches long (U. S. N. M. No. 43), in fair condition; head, 4½; depth, 4¾; eye, 3¼. Two other specimens from Pecos River, collected by Capt. John Pope, are probably the types of *Dionda papalis*; these fully agree with the types of *D. serena*. This species differs from *D. episcopa* chiefly in the more slender body, more pointed nose, somewhat smaller eye, and larger scales.

42. Hybognathus nuchalis Agassiz. Rio Grande near San Ildefonso, N. Mex. (Cope & Yarrow, 1875). Red River at Fulton, Ark., Sabine River at Longview, and Trinity River at Dallas (Jordan & Gilbert, 1886). We found this species very abundant in the Neches River east of Palestine, in Trinity River at Magnolia Point, and in Big White Oak Bayou at Houston. Fulton Creek, near Creswell (Coate).

43. **Pimephales promelas confertus** (Grd.). Hurrah Creek, a tributary of the Rio Pecos (as *Hyborhynchus confertus* types, Girard, 1856, and Girard, 1858, pl. LIX, figs. 11–15). San Ildefonso, N. Mex. (as *Hybognathus nigellus*, Cope, types, Cope & Yarrow, 1875). Brownsville (as *Pimpehales nigellus* and *Pimephales promelas*, Jordan, 1878). Rio Grande (as *Hybognathus confertus*, Synopsis). Fulton Creek, near Creswell (Coate).

44. **Pimephales notatus** (Raf.). Twenty miles west of Choctaw Agency (as *Hyborhynchus tenellus* types, Girard, 1856, and Girard, 1858). Rio Colorado at Austin (Jordan & Gilbert, 1886).

45. **Cochlognathus ornatus** B. & G. Brownsville (types of genus and species, Baird & Girard, 1854). Brownsville (Girard, 1856 and 1859, pl. XXXV, figs. 12–17). Trinity River at Fort Worth (as *Cochlognathus biguttata* types, Cope, 1880). Rio Grande (Synopsis). Trinity River (as *Cochlognathus biguttatus*, Synopsis). The types of *Cochlognathus ornatus* (5 specimens, 2½ to 3 inches long, U. S. N. M. No. 150) are in fair condition. One of the five so labeled is in excellent condition, much fresher in appearance than the other four, and probably belongs in some other bottle.

46. **Cliola vigilax** (B. & G.). This species was described, as *Ceratichthys vigilax*, by Baird & Girard, in 1853, from specimens caught in Otter Creek, Arkansas, by Capts. R. B. Marcy and Geo. B. McClellan. San Pedro Creek, a tributary of San Antonio River (as *Cliola velox* types, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 21–24). Leon River, a tributary of San Antonio River (as *Cliola vivax* types, Girard, 1856, and Girard, 1858). Otter Creek, tributary of Red River, Arkansas (Girard, 1856, and Girard, 1858). San Pedro Creek (as *Cliola velox*, Girard, 1858). Sabine River at Longview, Rio Lampasas at Belton, Trinity River at Dallas, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Long Lake, Trinity River, and Neches River near Palestine, Rio San Marcos at San Marcos, Guadalupe River at New Braunfels, Hunter Creek, Buffalo Bayou, and Big White Oak Bayou near Houston (Evermann, 1892).

47. **Notropis cayuga atrocaudalis** Evermann. Kilper's Pond, Big White Oak Bayou, Buffalo Bayou, and Hunter Creek near Houston; Rio San Marcos at San Marcos, Guadalupe River near New Braunfels, and Rio San Antonio at San Antonio (types, Evermann, 1892). There are in the National Museum (No. 17814) 31 specimens of this minnow that were collected by Messrs. Earll and Kumlein in Clear Creek, Waller County, Tex. They agree perfectly with the types.

48. **Notropis nitidus** (Grd.). Cadereita, New Leon (as *Moniana nitida* types, Girard, 1856, and Girard, 1859). The types of this species consist of two specimens, 2¼ and 2¾ inches long, respectively (No. 39657, U. S. N. M.), and are in good condition except that the tails are considerably broken. Head, 4⅓; depth, 3⅓; eye, 3⅓, = snout; D. I, 8; A. I, 7; scales, 6–35–3. Larger mouth and eye than in *Notropis lutrensis*.

49. **Notropis nux** Evermann. Neches River, Trinity River, and Long Lake near Palestine (types, Evermann, 1892).

50. **Notropis deliciosus** (Grd.) Leon River, a tributary of the Rio San Antonio (as *Moniana deliciosa* types, Girard, 1856, and Girard, 1858). Brownsville (as *Alburnops missuriensis*, Jordan, 1878). Rio Grande (as *Cliola missuriensis*, Synopsis). Rio Lampasas at Belton, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Kilper's Pond, Big White Oak Bayou, Buffalo Bayou, and Hunter Creek at Houston; San Antonio River at San Antonio, Guadalupe River at New Braunfels, and Rio San Marcos at San Marcos (Evermann, 1892). Fulton Creek near Creswell (Coate). The types of *Moniana deliciosa* consist of 13 specimens (No. 119, U. S. N. M.) and are in rather bad condition. The variation in the size of the mouth among these specimens is noticeable, though it is not great.

51. **Notropis sabinæ** J. & G. Sabine River, Longview (type, Jordan & Gilbert, 1886). The five specimens in the Museum as the types of this species (No. 36484) are 1 to 2 inches long and are in good condition.

52. **Notropis nocomis** Evermann. Rio Comal at New Braunfels (as *Notropis deliciosus* in part, Jordan & Gilbert, 1886). Trinity River at Magnolia Point and San Marcos River at San Marcos (types, Evermann, 1892). There are two specimens in the National Museum from the Trinity River at Dallas, which were collected by Jordan & Gilbert in 1884.

53. **Notropis simus** (Cope). San Ildefonso, N. Mex. (as *Alburnellus simus* Cope, types, Cope & Yarrow, 1875, pl. XXXI, figs. 2, 2*a*, and Synopsis). There are in the Museum (No. 16982) about 75 specimens which appear to be the types of this species; they are 3¼ inches long or less

and are in fairly good condition. Head, 4; depth, 4; eye, 4; snout a little longer than eye. D. I, 8; A. II, 9; scales, 6-37-3, 20 before the dorsal. Origin of dorsal nearer snout than base of caudal; mouth rather large, little oblique, lower jaw not projecting; snout blunt. There are 6 other specimens of this species in the Museum (No. 36795), said to have been collected in the Pecos River by Capt. Pope.

54. Notropis ornatus (Grd.). Chihuahua River and tributaries (as *Codoma ornata* type, Girard, 1856, and Girard, 1859, pl. XXIX, figs. 22–25). The types (U. S. N. M. No. 38247) are two fine specimens, 2¼ inches long. The fins are still quite dark and the species is a well-marked one. Specimens were obtained in 1891 at Chihuahua by Mr. Woolman.

55. Notropis chihuahua Woolman. Rio de las Conchas, Chihuahua, Mexico (types, Woolman, 1892). Numerous specimens of this minnow were obtained by Mr. Woolman, ten of which are deposited in the National Museum (No. 44151); from these the following description has been drawn up: Head, 3⅓ to 4; depth, 4 to 4⅔; eye, 3 to 3¼; snout, 3⅔ to 4; interorbital width=eye. Body moderately slender, back but little elevated; head heavy, bluntly conic, snout decurved; mouth small, somewhat oblique, upper lip on a level with the pupil, maxillary scarcely reaching front of eye; lower jaw not projecting, broadly rounded, the dentary bones being widely separated; teeth, 4–4, hooked, the grinding surface narrow. Dorsal, II, 8, the first of the two rudimentary spines very short, origin of dorsal fin directly over the ventrals and midway between tip of snout and base of caudal, its height 1¼ in head; anal, I, 7, its base 1⅔ in head; pectorals short, not reaching the ventrals; ventrals quite short, not reaching vent; scales, 5-34-3, 15 before the dorsal; lateral line complete and but little decurved. Color, as given by Mr. Woolman, light brown above; edges of scales above lateral line with small but closely placed black dots; body also above lateral line thickly but irregularly sprinkled with dark-brown spots, these gradually becoming more numerous toward the median line of the back where they form a vertebral line; the sides with a plumbeous stripe as wide as eye, which extends forward through the eye and around the snout, thickly sprinkling the upper lip with small dots, but not touching the lower lip; an irregular dark spot at base of tail; sides below lateral line silvery; fins all plain except dorsal and caudal, which are dusky but without distinct marking; peritoneum silvery.

56. Notropis leoninus (Grd.). Leon River, tributary of the Rio San Antonio (as *Moniana leonina* types, Girard, 1856, and Girard, 1858, pl. LIX, figs. 6–10). Rio Salado, Rio Sabinal, and Rio Medina, all tributaries of the Rio San Antonio; also in the Rio Nueces and the Rio Frio, a tributary of the Rio Nueces (as *Moniana frigida* types, Girard, 1856). Rio Frio, a tributary of the Nueces (as *Moniana frigida*, Girard, 1858, pl. LIX, figs. 16–20). Rio Sabinal, Rio Salado, and Rio Medina (as *Moniana frigida*, Girard, 1859, pl. XXX, figs. 17–20). Brownsville (as *Moniana complanata* types, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 17–20). Brownsville (as *Cyprinella complanata*, Jordan, 1878). The types *Moniana frigida* (U. S. N. M. No. 124) are 51 specimens, 3½ inches long or less, and are still in excellent condition. Head, 4⅛; depth, 3⅔; eye 3⅔, less than snout; D. I, 8; A. I, 9; scales, 7–35–3. Not greatly different from *Notropis lutrensis*.

57. Notropis lutrensis (B. & G.). Otter Creek, Arkansas (as *Leuciscus lutrensis* types, Baird & Girard, 1853). Otter Creek, a tributary of the northern fork of Red River, Arkansas, also Gypsum Creek, a tributary of the False Washita (as *Moniana lutrensis*, Girard, 1856, and Girard, 1858). China, New Leon (as *Moniana couchi* types, Girard, 1856, and Girard, 1859, pl. XXX, figs. 21–24). Cadereita, New Leon, Mexico, (as *Moniana rutila* types, Girard, 1856, and Girard, 1859, pl. XXX, figs. 1–4). Near Monterey, New Leon, Mexico (as *Moniana gracilis* types, Girard, 1856, and Girard, 1859). Brownsville (as *Moniana gibbosa* types, Girard, 1856, and Girard, 1859, pl. XXX, figs. 9–12). Hurrah Creek, a tributary of the Rio Pecos (as *Moniana lætabilis* types, Girard, 1856, and Girard, 1858). Near San Antonio (as *Cyprinella suavis* types, Girard, 1856, and Girard, 1858). San Ildefonso, N. Mex. (as *Hypsilepis iris* Cope, types, Cope & Yarrow, 1875, pl. XXXI, figs. 4, 4*a*, 5, 5*a*). Upper Rio Grande (as *Cliola iris*, Synopsis). Rio Grande (as *Cliola gibbosa*, Synopsis). Trinity River at Fort Worth and Dallas (as *Moniana jugalis*, var., Cope, 1880). Sabine River at Longview, Rio Lampasas at Belton, Trinity River at Dallas, Rio Colorado at Austin, Rio Blanco at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Neches River and Trinity River near Palestine, Guadalupe River at New Braunfels, and San Antonio River at San Antonio (Evermann, 1892). Fulton Creek near Creswell (Coate).

The following notes have been made upon the type specimens of these various nominal species, all of which are now in the National Museum:

Moniana lutrensis (No. 104). Four specimens, 1¼ to 1¾ inches long, in fair condition. Head, 3¾; depth, 3¼; eye, 4; D. I, 8; A. I, 9; scales, 7–34–3. These specimens are very dark and look as though they had been taken in muddy water or water containing staining matter. These were collected by Capt. George B. McClellan in 1853.

Moniana gracilis (No. 116). Four specimens, 1¾ inches long. These are all males, in good condition. Head, 3¾; depth, 3¼; eye, 3¾; D. I, 7; A. I, 8; scales, 7–35–3.

Moniana couchi (No. 103 or, new series, 20227). Two specimens, 1¾ and 2¼ inches, respectively, in good condition. Head, 3¾; depth, 3⅓; eye, 3⅔; snout, 3⅞; D. I, 8; A. I, 8; scales, 7–35–3. One of the two has the head a little longer (3½) and the depth a trifle less (3¼). There are in another bottle 32 small specimens, 14 of them under 1½ inches each, that are a part of the types of *M. couchi*. They are all in very good condition and agree perfectly with the types of *M. lutrensis*.

Hypsilepis iris (No. 16976). One specimen, 2¼ inches long, in fair condition. Head, 3¾; depth, 3⅛; eye, 4⅛,=snout; D. I, 8; A. I, 9; scales 7–33–2; height of dorsal fin 1⅓ in length of head, 1½ in base of fin. Three other bottles (Nos. 16976, 16977, and 16980) contain several dozen small minnows in poor condition. They are all from San Ildefonso, N. Mex., and are labeled as the types of *Hypsilepis iris*. Most of them are that species, but each bottle contains also a number of specimens of *Rhinichthys dulcis*, *Leuciscus pulchellus*, and perhaps still other species.

58. **Notropis proserpina** (Grd.). Devil River (as *Moniana proserpina* types, Girard, 1856, and Girard, 1859). Piedra Painte, N. Mex. (as *Moniana aurata* types, Girard, 1856, and Girard, 1859, pl. xxx, figs. 13–16). There are in the Museum 8 specimens (117=2702) marked as the types of this species; the largest is 2¼ inches long, and all are in fairly good condition. Head, 4¼; depth, 4; eye, 3⅓; D. I, 8; A. I, 7; scales, 6–36–3, the lateral line interrupted; snout blunt and decurved, the lower jaw included, and the mouth small; side with a broad greenish, plumbeous band.

59. **Notropis formosus** (Grd.). Rio Mimbres, Chihuahua (as *Moniana formosa* types, Girard, 1856, and Girard, 1859, pl. xxx, figs. 5–8). Rio Mimbres (as *Cliola formosa*, Synopsis).

60. **Notropis bubalinus** (Baird & Girard). Otter Creek, Arkansas (as *Leuciscus bubalinus* types, Baird & Girard, 1853). Coal Creek, a southern tributary of Canadian River, Arkansas, and 20 miles west of Choctaw Agency (as *Cyprinella umbrosa* types, Girard, 1856, and Girard, 1858, pl. LVII, figs. 1–5). Otter Creek, a tributary of the north fork of Red River, Arkansas (as *Cyprinella bubalina*, Girard, 1856, and Girard, 1858). Brownsville (as *Cyprinella bubalina*, Jordan, 1878). The types of *C. umbrosa* are in excellent condition; they consist of 4 specimens, each about 3 inches long, and were collected by H. B. Möllhausen. They give the following measurements: Head, 3⅝; depth, 2⅓; eye, 3¼; D. I, 8; A. I, 9; scales, 7–35–3, 13 before the dorsal. This species is chiefly distinguished by the great depth of the body.

61. **Notropis lepidus** (Grd.). Rio Frio, a tributary of the Rio Nueces (as *Cyprinella lepida* types, Girard, 1856, and Girard, 1858, pl. LVIII, figs. 21–25). Rio Frio (as *Cliola lepida*, Synopsis).

62. **Notropis garmani** Jordan. Tributaries of Lago del Muerte, Parras, Coahuila, Mexico (as *Cyprinella rubripinna* types, Garman, 1881), and same locality (as *Cliola rubripinna*, Synopsis, and as *Notropis garmani* nom. sp. nov., Jordan, 1885).

63. **Notropis macrostomus** (Grd.). Devil River, Texas, and China, New Leon, Mexico (as *Cyprinella macrostoma* types, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 5-8. San Pedro Creek, tributary of Rio San Antonio (as *Cyprinella luxiloides* types, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 13-16). The types of this species are three specimens (U. S. N. M. No. 129), the largest 2¼ inches long, the other two 1¾ inches each, in fair condition. Head, 3⅜; depth, 3¾; eye 3, greater than snout; mouth large, maxillary reaching pupil. D. I, 8; A. I, 8; scales, 5–36–3; origin of dorsal fin nearer snout than base of caudal.

64. **Notropis venustus** (Grd.). Rio Sabinal (as *Cyprinella venusta* types, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 1–4). Johnson Fork of Llano River (*Cyprinella venusta*, Cope, 1880). San Saba River and Clear Creek (as *Cliola urostigma* types, Jordan & Meek, 1884). Red River at Fulton, Ark., Sabine River at Longview, Rio Lampasas at Belton, and Rio Colorado at Austin (Jordan & Gilbert, 1886). Neches River and Trinity River near Palestine,

Buffalo Bayou and Big White Oak Bayou at Houston, and Hunter Creek near Houston (Evermann, 1892). The types of *Cliola urostigma* now in the National Museum are 10 specimens (No. 20446) from the San Saba near Fort McKavett, and 8 (No. 17812) from Clear Creek near Hempstead, the latter being in good condition. All of these agree perfectly with the numerous specimens collected by us in 1891, and with Girard's plate.

65. **Notropis notatus** (Grd.). Rio Seco, a tributary of the Rio Nueces (as *Cyprinella notata* types, Girard, 1856, and Girard, 1858, pl. LVIII, figs. 16–20). Rio Seco (as *Cliola notata*, Synopsis). Rio Colorado at Austin (Jordan & Gilbert, 1886). The types (U. S. N. M. No. 136) are two small specimens in fair condition.

66. **Notropis texanus** (Grd.). Rio Salado and Turkey Creek (as *Cyprinella texana* type, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 9–12). Rio Lampasas at Belton, and Trinity River at Dallas (Jordan & Gilbert, 1886). Six of the types of this species are in the National Museum (No. 182), but are in very bad condition; they are each about 2¼ inches long, and present the following characters: Head, 4; depth, 4; eye, a little more than 3; D. I, 8; A. I, 7; scales, 6–37–4, 15 before the dorsal. The mouth is rather large, not greatly oblique, lower jaw barely included, the maxillary reaching the front of the orbit. Lateral line slightly decurved. Silvery, the caudal spot small and indistinct. Compared with specimens of *Notropis venustus* of the same size, the mouth is larger, the snout longer and more pointed, and the caudal spot is much less distinct. There is one specimen of this same lot in the Philadelphia Academy's Museum, which was examined by Prof. Meek a few years ago.

67. **Notropis amabilis** (Grd.). Rio Leona, an affluent of the Rio Nueces (as *Alburnus amabilis* types, Girard, 1856, and Girard, 1859, pl. XXIX, figs. 10–13). Rio Leona (as *Minnilus amabilis*, Synopsis).

68. **Notropis socius** (Grd.). Live Oak Creek (as *Alburnus socius* types, Girard, 1856, and as *Alburnellus socius*, Girard, 1859, pl. XXIX, figs. 14–17). Pecos River (U. S. N. M., Capt. Pope). There are 20 specimens in the Museum, the types of this species (No. 70, or 39654 new series); they are 2¼ inches or less in length and are in very poor condition; teeth 1, 4–4, 1; head, 3⅗; depth, 3⅗: eye 3, = distance from tip of snout to pupil; mouth large and oblique. Besides these 20 types there are 151 other specimens of this species (U. S. N. M. No. 3394) from the Pecos River, collected by Capt. John Pope.

69. **Notropis swaini** J. & G. San Felipe Creek (as *Alburnus megalops* types, Girard, 1856, and as *Alburnellus megalops*, Girard, 1859, pl. XXIX, figs. 1–4). Rio Comal at New Braunfels, Rio San Marcos at San Marcos, and Rio Colorado at Austin (Jordan & Gilbert, 1886). Comal Creek at New Braunfels and San Marcos River at San Marcos (Evermann, 1892).

70. **Notropis umbratilis** (Grd.). Coal Creek, a tributary of the south fork of Canadian River, and 20 miles west of the Choctaw Agency (as *Luxilus lucidus* types, Girard, 1856, and Girard, 1858, pl. LX, figs. 9–12). The types of this species, described by Girard as *Alburnellus umbratilis*, were obtained by H. B. Möllhausen in Sugar Loaf Creek, Arkansas. They are 47 in number (U. S. N. M. No. 73), each about 2¼ inches or less in length, and in good condition. Head, 4¼; depth, 4¼; eye, 4; mouth large, considerably oblique; lower jaw projecting; head, pointed. D. I, 8; A. I, 11; scales, 9–44–2¼, 26 before the dorsal.

71. **Notropis dilectus** (Grd.). San Ildefonso, N. Mex. (as *Alburnellus jemezanus* Cope, types, Cope & Yarrow, 1875). Red River at Fulton, Ark., and Sabine River at Longview (Jordan & Gilbert, 1886). Long Lake near Magnolia Point, Neches River east of Palestine, and Trinity River at Magnolia Point (Evermann, 1892). Fulton Creek near Creswell (Coate).

72. **Notropis fumeus** Evermann. Hunter Creek near Houston (types, Evermann, 1892).

73. **Notropis notemigonoides** Evermann. Neches River east of Palestine and Sims Bayou near Houston (types, Evermann, 1892).

74. **Phenacobius mirabilis** (Grd.). Brownsville (as *Phenacobius scopiferus*, Jordan, 1878). Sabine River at Longview, and Trinity River at Dallas (Jordan & Gilbert, 1886). Trinity River at Magnolia Point near Palestine (Evermann, 1892).

75. **Rhinichthys dulcis** (Grd.). Rio Grande at Del Norte and Alamosa, Colo., and Rio Conejos near Alamosa, Colo. (Jordan, 1889). Abiquiu, Costilla Creek, Taos, and San Ildefonso, N. Mex. (as *Rhinichthys maxillosus*, Cope & Yarrow, 1875). Coahuila, Mexico (as *Rhinichthys simus* types, Garman, 1881).

76. **Agosia oscula** (Grd.). "New Mexico" and "Rio Grande basin" (as *Apocope ventricosa* Cope, types, Cope & Yarrow, 1875, pl. XXVIII, figs. 1, 1*a*). The occurrence of this species in the Rio Grande basin is doubtful.

77. **Agosia yarrowi** Jordan & Evermann. Rio Grande, Colorado (as *Apocope oscula* types, Cope & Yarrow, 1875, not *Argyreus oscula* of Girard). The occurrence of this minnow in the Rio Grande basin is also doubtful.

78. **Hybopsis storerianus** (Kirtland). Red River at Fulton, Ark. (Jordan & Gilbert, 1886).

79. **Hybopsis æstivalis** (Grd.). Rio San Juan near Cadereita, New Leon (as *Gobio æstivalis* types, Girard, 1856; Girard, 1858, pl. LVII, figs. 17–20; and Girard, 1859). Rio Grande at San Ildefonso, N. Mex. (*Ceratichthys sterletus* Cope, types, Cope & Yarrow, 1875, pl. XXVII, figs. 3, 3*a*). Red River at Fulton, Ark., and Rio Colorado at Austin (Jordan & Gilbert, 1886). Rio Grande in New Mexico (as *Ceratichthys sterletus*, Synopsis). Rio San Juan, Cadereita, New Leon (as *Ceratichthys æstivalis*, Synopsis). The type of *C. sterletus* (U. S. N. M. No. 16973) is a single specimen about 3 inches long and in good condition. Head, 4; depth, 5; eye, 4¼; snout, 2¼.

80. **Hybopsis æstivalis marconis** J. & G. Rio San Marcos at San Marcos (types) and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). San Marcos River at San Marcos and Guadalupe River at New Braunfels (Evermann, 1892). Probably identical with *H. æstivalis*.

81. **Semotilus atromaculatus** (Mitch.). Twenty miles west of the Choctaw Agency (as *Leucosomus incrassatus* types, Girard, 1856, and Girard, 1858, pl. LXI, figs. 1–6). Antelope Creek, Arkansas (as *Leucosomus pallidus* types, Girard, 1856, and Girard, 1858, pl. LXI, figs. 6–10).

82. **Stypodon signifer** Garman. Parras, Coahuila (type, Garman, 1881).

83. **Leuciscus nigrescens** (Grd.). Rio Mimbres, tributary of Lake Guzman (*not* the Gila) (as *Gila pulchella* types, Baird & Girard, 1854). Chihuahua River and tributaries (as *Tigoma pulchra* types, Girard, 1856, and Girard, 1859, pl. XXXII, figs. 5–8). Rio Mimbres, tributary of Lake Guzman, Mexico (as *Tigoma pulchella*, Girard, 1856, and Girard, 1859, pl. XXXI, figs. 5–8). Sangre de Christo Pass, from a tributary of the Rio Grande (as *Clinostomus pandora* types, Cope, 1872). Rio Grande, mouth of the Rio Hondo, and Rio Grande near San Ildefonso, N. Mex. (as *Gila pandora*, Cope & Yarrow, 1875). Chihuahua River (as *Squalius pulcher*, Synopsis). Lake Guzman (as *Squalius pulchellus*, Synopsis). Rio Grande at Del Norte and Alamosa, Colo., and Rio Conejos near Alamosa (as *Leuciscus pulcher*, Jordan, 1891). Rio de Acama, N. Mex. (as *Gila gula* types, Cope & Yarrow, 1875). Rio Grande at Loma, Colo. (as *Gila egregia*, Cope & Yarrow, 1875). Boca Grande and Janos River (as *Tigoma nigrescens* types, Girard, 1856, and Girard, 1859, pl. XXXII, figs. 1–4). Parras, Coahuila (as *Cheonda nigrescens*, Garman, 1881). An examination of the original description and a study and comparison of the types of these various nominal species named above convinces us that the synonymy should stand as here given. In the following table we give measurements and other data drawn from the material now in the National Museum.

Nominal species.	U. S. N. M. No.	Total length.	Head in length.	Depth in length.	Eye in head.	Snout in head.	Dorsal.	Anal.	Scales.	Locality.
		Inches.								
Gila pulchella, types	283	6¼	4	4⅓	5½	3⅓	I, 9	I, 8	16–67–7	Rio Mimbres.
	233	3⅓	3⅓	4⅓	4¾	4	I, 9	I, 8	16–73–9	Do.
Tigoma pulchra, types	227	5¼	3⅗	3¾	4¾	3½	I, 8	I, 8	....	Rio Chihuahua.
	227	4⅛	3⅓	4⅓	4	4	I, 8	I, 8	20–70–9	Do.
	228	5¼	4	4	4¾	3⅓	I, 8	I, 8	....	Do.
	228	5	4	4	4⅘	3⅓	I, 8	I, 8	17–63–10	Do.
	228	3⅓	3¾	3¾	3¾	3¾	I, 8	I, 8	....	Do.
Tigoma nigrescens, types.	219	3¾	3⅞	4	4	4	I, 9	I, 8	17–67–8	Rio Janos.
	220	5¾	3¾	4	5½	3⅓	I, 9	I, 8	17–67–8	Boca Grande.
	220	3	3¾	4⅓	4	4	I, 9	I, 8	17–68–9	Do.
Gila egregia	15800	5¾	4	4¾	4⅓	3⅓	I, 8	I, 8	16–64–8	San Ildefonso.
	15800	3⅓	3⅓	3⅕	4	3⅔	I, 8	I, 8	16–69–8	Do.
Gila pandora, types	15984	6⅓	4	4	4⅓	3⅓	I, 8	......	17–67–10	Rio Hondo, N. Mex.
	15984	6	4	4	4¾	3⅓	....	......	17–63–10	Do.
	15984	5¾	4⅓	4⅓	4⅓	3⅓	....	......	16–63–10	Do.
	15984	4½	4	4	4	3⅓	I, 8	I, 8	16–60–8	Do.
	41628	8	4¼	4⅓	5⅓	3½	I, 8	I, 8	17–65–8	Rio Grande at Del Norte, Colo.
	41628	5¾	4	4	5	3½	I, 8	I, 8	17–64–11	Do.

This is a very variable species, a fact shown not only by the several nominal species which we have united in the above synonymy, but as well by the different individuals of any one of the types. However, as shown in the table, the variations are, chiefly a least, in parts which in this group are not of value for purposes of classification. The size and number of the scales have heretofore been used for this purpose, but, as may be seen, the variation in squamation among the individuals of any one of the types, for example, *Tigoma pulchra*, is as great as among the types of the several nominal species. We have not been able to find the types of *Gila gula*, which probably also belongs here.

84. **Leuciscus conspersus** (Garman). Nazas River, Coahuila (as *Gila conspersa* type, Garman, 1881), Saltillo, Coahuila (as ? *Cheonda modesta* types, Garman, 1881).

85. **Opsopœodus oscula** Evermann. Neches River and Long Lake near Palestine. Buffalo Bayou, Sims Bayou, and Kilper's Pond near Houston. Dickinson Bayou at Nicholstone (types, Evermann, 1892).

86. **Notemigonus chrysoleucus** (Mitchill). Rio Seco, a tributary of the Rio Nueces (as *Luxilus seco* types, Girard, 1856, and Girard, 1858). Dry Creek near Victoria (as *Luxilus leptosomus* types, Girard, 1856, and Girard, 1859, pl. XIX, figs. 9–12). Brownsville (Jordan, 1878). Neches River, Long Lake, and Trinity River near Palestine. Sims Bayou, Kilper's Ponds and Big White Oak Bayou near Houston. Dickinson Bayou near Dickinson (Evermann, 1892). Fulton Creek near Creswell (Coate). The type of *Luxilus leptosomus* is 4½ inches long (U. S. N. M. No. 61) and is very mellow. It does not differ from *Notemigonus chrysoleucus*.

X.—CHARACINIDÆ. THE CHARACINS.

87. **Tetragonopterus argentatus** (B. & G.). Upper tributaries of the Rio Nueces (as *Astyanax argentatus* types, Baird & Girard, 1854). Rio Nueces, Rio Leona, Rio Sabinal, mouth of the Rio Grande, Zoquito, Comanche Springs, Elm Creek, Turkey Creek, San Felipe, Devil River, and Brownsville (as *Astyanax argentatus*, Girard, 1859, pl. VIII, figs. 5-9).

XI.—HIODONTIDÆ. THE MOON-EYES.

88. **Hiodon alosoides** (Raf.). Red River at Fulton, Ark. (Jordan & Gilbert, 1886).

XII.—ELOPIDÆ. THE BIG-EYED HERRINGS.

89. **Megalops atlanticus** C. & V. Galveston (Jordan & Gilbert, 1882).

XIII.—CLUPEIDÆ. THE HERRINGS.

90. **Clupea chrysochloris** (Raf.). Red River at Fulton, Ark., and Galveston (Jordan & Gilbert, 1882 and 1886).

91. **Harengula arcuata** (Jenyns). Nine specimens from Galveston and Corpus Christi. *Clupea humeralis* Cuv. & Val. and *Harengula pensacolæ* Goode & Bean seem to be identical with this species.

92. **Opisthonema thrissa** (Osbeck). Galveston (Jordan & Gilbert, 1882).

93. **Brevoortia tyrannus patronus** Goode. Brazos Santiago (as *Brevoortia patronus* types, Goode, 1878). Galveston (Jordan & Gilbert, 1882). One young specimen obtained by us at Galveston. The differences said to distinguish the Gulf menhaden from the common form are not of great value. Our specimen shows no differences in the scales, but the fins are a trifle larger or longer than in specimens of the same size from further north.

94. **Dorosoma cepedianum** (Le S.). Galveston (Jordan & Gilbert, 1882). Red River at Fulton, Ark., and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). This worthless fish was very abundant in Long Lake near Magnolia Point and in Kilper's Ponds at Houston.

XIV.—ENGRAULIDÆ. THE ANCHOVIES.

95. **Stolephorus browni** (Gmelin). *Anchovy*. The collection made at Galveston contains seven specimens of this species.

96. **Stolephorus mitchilli** (C. & V.). Galveston (Jordan & Gilbert, 1882). A few specimens taken at Galveston, Corpus Christi, and in Dickinson Bayou.

XV.—SCOPELIDÆ. THE SCOPELIDS.

97. **Synodus fœtens** (L.). Texas coast (as *Saurus mexicanus*, Girard, 1859). Two specimens from Galveston—one 4 inches long, which does not fully agree with the description of *S. fœtens*. Head, 4⅓; depth, 7¼; eye, 4⅓; dorsal, 11; anal, 14. Scales before dorsal about 25; lateral line, 64; oblique series between lateral line and origin of dorsal, 5.

XVI.—SALMONIDÆ. THE SALMON FAMILY.

98. **Salmo mykiss spilurus** Cope. Sangre de Christo Pass, in Colorado, from one of the sources of the Rio Grande (as *Salmo spilurus* types, Cope, 1872). Utah Creek, and at Sangre de Christo Pass, a tributary to the Rio Grande (as *Salar virginalis* types, Girard, 1856, and Girard, 1858, pl. LXXIII, figs. 1–4). Brazos River, one of the principal tributaries of the Chama (as *Salmo spilurus*, Cope & Yarrow, 1875). Fort Garland, Colorado; Rio Grande, Colorado; Costilla, Rio Taos, Rio Chama, and near San Ildefonso, New Mexico (as *Salmo pleuriticus*, Cope & Yarrow, 1875). Rio Grande (as *Salmo spilurus* and *Salmo spilurus pleuriticus*, Synopsis). Brazos River, New Mexico, (as *Salmo spilurus*, Bean, 1883). Mountain streams of the Upper Rio Grande basin (Jordan & Gilbert, 1883). Streams of the Sierra Madre of Mexico at an elevation of between 7,000 and 8,000 feet, in the southern part of Chihuahua, near the southern boundaries of Durango and Sinaloa (as *Salmo purpuratus*, Cope, 1888, and Bean, 1888). Rio Grande (Forest and Stream, 1877). Limpia, Devil River, San Felipe Springs, and headwaters of the Canadian River, Texas, and Rio Bonito, New Mexico (as *Salmo fontinalis*, Forest and Stream, 1878). Cope's type of *Salmo spilurus* (U. S. N. M. No. 17067) is about 18 inches long and in good condition. It is labeled as from the Rio Brazos, New Mexico, which is probably incorrect, as Cope states the types came from Sangre de Christo Pass, Colorado. The trout mentioned in the Pacific Railroad Reports by Lieut. Marshall as occurring in the upper waters of the Sacramento (a tributary of the Pecos) and in the upper waters of the Colorado and Brazos rivers was of course this trout if trout at all. As no collecting has been done in that region since 1854, these early reports have not been verified. The distribution of the trout of the Rio Grande basin furnishes a very interesting and proper subject for investigation.

XVII.—CYPRINODONTIDÆ. THE CYPRINODONTS.

99. **Cyprinodon variegatus** Lacépède. Brackish waters of Indianola (as *Cyprinodon gibbosus* types, Baird & Girard, 1853, and Girard, 1859, pl. XXXVIII, figs. 1–7). Leon Springs, Rio Grande del Norte (as *Cyprinodon bovinus* types, Baird & Girard, 1853, Girard, 1859, pl. XXXVII, figs. 12–18, and Synopsis). Chihuahua River (as *Cyprinodon eximius* types, Girard, 1859, and Synopsis). Brownsville (Jordan, 1878). Indianola (as *Cyprinodon gibbosus*, Synopsis). Galveston Bay, Dickinson Bayou, and Corpus Christi (Evermann, 1892).

100. **Cyprinodon latifasciatus** Garman. Spring near Parras, Coahuila (type, Garman, 1881).

101. **Cyprinodon elegans** B. & G. Rio Grande del Norte (types, Baird & Girard, 1853), and Comanche Springs, Rio Grande del Norte (Girard, 1859, pl. XXXVIII, figs. 1–7). These two references are evidently to one and the same locality, and to the same specimens.

102. **Adinia multifasciata** Grd. Galveston, St. Joseph Island, and Indianola (types of genus and species, Girard, 1859*b*, and pl. XXXVIII, figs. 12–14, Girard, 1859, as the female of *Limia pœciloides*). Coast of Texas, ascending streams; our specimens from the Rio Grande (as *Fundulus adinia*, nom. sp. nov., Synopsis). Galveston (as *Fundulus xenicus*, Evermann, 1892).

103. **Fundulus pallidus** Evermann. Galveston Bay, near Swan Lake (type, Evermann, 1892, pl. XXXV, fig. 2).

104. **Fundulus similis** (B. & G.). Brackish waters in the vicinity of Indianola (as *Hydrargyra similis* types, Baird & Girard, 1853, and Girard, 1859, pl. XXXV, figs. 1–8). Brownsville (as *Hydrargyra similis*, Jordan, 1878). Galveston (Jordan & Gilbert, 1882). Galveston and Corpus Christi (Evermann, 1892).

105. **Fundulus zebrinus** J. & G. "Between Fort Defiance and Fort Union, New Mexico" (as *Hydrargyra zebra*, Girard, 1859*b*). Brownsville (as *Fundulus zebra*, Jordan, 1878). Fulton and Spring creeks near Creswell (Coate).

106. **Fundulus diaphanus** (Le S.). Comanche Creek, Mason County (Cope, 1880).

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107. **Fundulus heteroclitus grandis** B. & G. Brackish waters in the vicinity of Indianola (as *Fundulus grandis* types, Baird & Girard, 1853, and Girard 1859, pl. XXXVI). Brownsville (Jordan, 1878). Dickinson Bayou at Nicholstone, Galveston Bay, and Corpus Christi (Evermann, 1892).

108. **Zygonectes funduloides** Evermann. Dickinson Bayou near Dickinson (types, Evermann, 1892, pl. XXXV, fig. 3).

109. **Zygonectes pulvereus** Evermann. Dickinson Bayou near Dickinson, Buffalo Bayou near Houston, and Oso Creek near Corpus Christi (types, Evermann, 1892, pl. XXXVI, fig. 1).

110. **Zygonectes jenkinsi** Evermann. Dickinson Bayou near Dickinson and Galveston Bay (types, Evermann, 1892, pl. XXXVI, fig. 2).

111. **Zygonectes notatus** (Raf.). Trinity River at Fort Worth (Cope, 1880). Red River at Fulton, Ark., Sabine River at Longview, Rio Lampasas at Belton, Trinity River at Dallas, and Rio Colorado at Austin (Jordan & Gilbert, 1886). Neches River east of Palestine, Long Lake and Trinity River at Magnolia Point, Buffalo and Big White Oak bayous at Houston, and San Antonio Springs at San Antonio (Evermann, 1892).

112. **Zygonectes escambiæ** Bollman. Pond on bank of Trinity River at Magnolia Point (Evermann, 1892).

113. **Lucania venusta** (Grd.). Indianola (as *Limia venusta* type, Girard, 1859, pl. XXXIX, figs. 20–23; and as *Lucania venusta*, gen. nov., 1859*b*). Matamoras (as *Lucania affinis* types, Girard, 1859*b*). Indianola (Synopsis).

114. **Lucania parva** (B. & G.). Sims Bayou near Houston, Dickinson Bayou near Dickinson, San Antonio Springs at San Antonio, and Corpus Christi (Evermann, 1892).

115. **Gambusia affinis** (B. & G.). Rio Medina and Rio Salado (as *Heterandria affinis* types, Baird & Girard, 1853, and as *Gambusia affinis*, Girard, 1859, pl. XXXIX, figs. 12–15). "Inhabits the hydrographic basin of the Rio Nueces; specimens were collected in the Rio Sabinal, Rio Leona, Rio Nueces, and Elm Creek" (as *Heterandria patruelis* types, Baird & Girard, 1853). Rio Sabinal, Rio Leona, Rio Nueces, Elm Creek, and Turkey Creek (as *Gambusia patruelis*, Girard, 1859, pl. XXXIX, figs. 1–7). Leona and Comanche Springs, valley of the Rio Grande del Norte (as *Heterandria nobilis* types, Baird & Girard, 1853), and Leon's Spring, Comanche Spring, and Zoquito (Girard, 1859, pl. XXXIX, figs. 8–11). Upper affluents of the Rio Nueces, Rio Leona, Rio Blanco, and Rio Seco (Girard, 1859*b*). Matamoras (as *Gambusia gracilis* types, Girard, 1859*b*, and as *Gambusia humilis*, nom. sp. nov. Günther, 1866). Trinity River at Fort Worth (as *Zygonectes brachypterus* types, Cope, 1880). Trinity River (as *Zygonectes brachypterus*, Synopsis). Galveston (Jordan & Gilbert, 1882). Red River at Fulton, Ark., Sabine River at Longview, Trinity River at Dallas, Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Rio San Diego, one of the affluents of the Rio San Juan, near Cadereita, New Leon (as *Gambusia speciosa* types, Girard, 1859*b*). Chihuahua River (as *Gambusia senilis* types, Girard, 1859*b*, and Synopsis). Upper affluents of the Rio Nueces, Rio Leona, Rio Blanco, and Rio Seco (Girard, 1859*b*). San Pedro Creek and Dry Creek near Victoria (as *Gambusia affinis*, Girard, 1859*b*). Comanche Spring (as *Gambusia nobilis*, Girard, 1859*b*). Neches River east of Palestine, Trinity River and Long Lake at Magnolia Point, Buffalo Bayou, Hunter Creek, Kilper's Ponds, Big White Oak Bayou, and Sims Bayou near Houston, Dickinson Bayou near Dickinson, San Antonio Springs at San Antonio, Comal Creek at New Braunfels, and Rio San Marcos at San Marcos (Evermann, 1892). Strict adherence to the A. O. U. rule of priority requires that the specific name *affinis* be applied to this fish.

116. **Mollienesia latipinna** Le S. Brownsville and Fort Brown (as *Pœcilia lineolata* types, Girard, 1859, pl. XXXV, figs. 9–11, and Girard, 1859*b*). Indianola (as *Limia pœciloides* types, Girard, 1859, pl. XXXVIII, figs 8–14, and Girard, 1859*b*). "Common about Matamoras, where it was collected by the late L. Berlandier, whose collection has since been purchased by Lieut. D. N. Couch, a lover and cultivator of natural sciences" (as *Limia matamorensis* types, Girard, 1859*b*). Lagoon at Palo Alto, Mexico (as *Limia formosa* types, Girard, 1859*b*). Galveston (Girard, 1859*b*, and Jordan & Gilbert, 1882). Corpus Christi, Galveston, Dickinson Bayou at Nicholstone, and Hunter Creek near Houston (Evermann, 1892). Hunter Creek is a clear, cold fresh-water stream, and the occurrence of this brackish-water species there must be regarded as very unusual.

117. **Pœcilia couchiana** (Grd.). Rio San Juan at Cadereta [Cadereita] and Monterey, in the province of New Leon (as *Limia couchiana* types, Girard, 1859*b*).

XVIII.—ESOCIDÆ. THE PIKES.

118. **Lucius vermiculatus** (Le S.). Six specimens from the Neches River, 14 miles east of Palestine, and one from the Trinity River at Magnolia Point.

XIX.—MURÆNIDÆ. THE MURÆNAS.

119. **Gymnothorax ocellatus nigromarginatus** (Grd.). St. Joseph Island (as *Neomuræna nigromarginata* type, Girard, 1859, pl. XLI).

XX.—ECHELIDÆ.

120. **Myrophis punctatus** Lutken. Galveston (as *Myrophis lumbricus* types, Jordan & Gilbert, 1882). We obtained one very young specimen of this species at Galveston and another at Corpus Christi.

XXI.—MURÆNESOCIDÆ.

121. **Neoconger mucronatus** Grd. St. Joseph Island (type, Girard, 1859).

XXII.—ANGUILLIDÆ. THE TRUE EELS.

122. **Anguilla chrysypa** Raf. Mouth of the Rio Grande and Matamoras (as *Anguilla tyrannus* type, Girard, 1859, pl. XL). "Three specimens from near Santa Fe, N. Mex." (as *Anguilla tyrannus*, Cope & Yarrow, 1875). Rio Colorado at Austin and Rio San Marcos at San Marcos (as *Anguilla anguilla rostrata*, Jordan & Gilbert, 1886). The specimen obtained by Jordan & Gilbert at San Marcos is a large individual, 32 inches long (U. S. N. M. No. 36512).

XXIII.—SCOMBERESOCIDÆ.

123. **Tylosurus longirostris** (Mitchill). Brazos and St. Joseph Island (as *Belone scrutator* types, Girard, 1859, pl. XIII). Galveston (Jordan & Gilbert, 1882). Also obtained by us at Galveston.

124. **Hemirhamphus unifasciatus** Ranzani. *Halfbeak*. Galveston (Jordan & Gilbert, 1882).

XXIV.—SYNGNATHIDAE. THE PIPEFISHES.

125. **Siphostoma floridae** J. & G. *Florida Pipefish*. This appears to be an abundant species at Corpus Christi, and the collection contains numerous specimens from that part of the bay near Shamrock Point on Mustang Island. Measurements of 12 specimens, all from this place, are given in the following table:

Dorsal rings.	Body rings.	Dorsal rays.	Head.	Snout in head.	Sex
1+6	17+32	32	6	1⅘	Female.
1+6	17+32	30	6	1⅘	Male.
1+6-	17+32	30	6	1⅘	Female.
1+6-	17+32	30	5⅚	1⅘	Female.
1+5½	17+32	30	6	1⅔	Male.
1+6	17+32	30	6	1⅘	Female.
1+6	17+32	....	....	....	Male.
1+6	17+32	32	6	1⅘	Male.
1+6	17+32	32	6	1⅞	Male.
1+6	17+32	30	6½	1⅘	Male.
1+6	17+32	33	6	1⅘	Female.
1+6	17+32	32	6	1⅘	Female.

It will be seen that these agree perfectly with Prof. Swain's description of this species (Proc. U. S. N. M. 1882, 312), except that the number of dorsal rays is three to five greater in every case.

126. **Siphostoma louisianæ** (Günther). *Louisiana Pipefish.* A specimen 8 inches long from Galveston Bay, a smaller one from Dickinson Bayou in brackish water, and another small one from Corpus Christi.

127. **Siphostoma fuscum** (Storer). *Common Pipefish.* Eleven specimens from Corpus Christi, measurements and other data of which are given in the following table. If this identification be correct the known range of this common species of pipefish is considerably extended to the southward.

Body rings.	Dorsal rings.	Rays.	Head.	Depth.	Height of fin in length.	Sex.
16–31	3–4	31	7	13	2¼	Female.
16–31	3–5	34	7	14	2½	Do.
16–31	4–4	32	7	17	3	Do.
16–31	4–3	30	7½	13½	2¼	Do.
16–31	4–4	33	7	17	3	Do.
16–31	4–4	34	7	13	2½	Do.
16–34	4–4	34	7½	16½	3	Do.
16–31	4–4	31	7½	16	2	Do.
16–31	4–4	31	7½	17	2½	Do.
16–31	5–3	31	7	18	2¾	Do.
16–32	4–4	31	7½	15½	2	Do.

XXV.—MUGILIDÆ. THE MULLETS.

128. **Mugil cephalus** L. *Striped Mullet.* St. Joseph Island, Indianola, Brazos Santiago, Brazos, and Galveston (as *Mugil berlandieri* types, Girard, 1859, pl. x, figs. 1–4). Galveston (as *Mugil albula,* Jordan & Gilbert, 1882). Common both at Galveston and Corpus Christi.

XXVI.—ATHERINIDÆ. THE SILVERSIDES.

129. **Labidesthes sicculus** (Cope). *Skipjack.* This fish has been found in Texas only in Long Lake near Magnolia Point, where we found seven specimens.

130. **Menidia vagrans** (Goode & Bean). *Silverside.* Galveston (Jordan & Gilbert, 1882).

131. **Menidia peninsulæ** (Goode & Bean). *Silverside.* This species was obtained by us at Corpus Christi, Galveston, and Dickinson Bayou. Seventeen specimens from Corpus Christi give the following measurements:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4½	5	3	IV-1, 8	1-16	38
4	5	3	IV-1, 8	1-16	38
4	5	3	V-1, 8	1-15	....
4	5	3	IV-1, 9	1-15	38
4	5	3	IV-1, 9	1-17	38
4	5½	3	IV-1, 9	1-17	38
4	5	3	?-1, 8	1-16	38
4	5	3	IV-1, 9	1-17	38
4	5	3	IV-1, 9	1-17	38
4	5	3	IV-1, 9	1-15	38
4	5	3	?-1, 9	1 15	36
4	5	3	V-1, 8	1-15	38
4	5½	3	V-1, 8	1 12?	38
4	5	3	V-1, 9	1 15	35
4½	4½	3	V-1, 8	1 15	36 or 37
4	4½	3	V-1, 8	1-16	39
4	5	3	V-1, 9	1-17	38

Eleven specimens from Galveston give the following measurements:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4	5⅓	3	V-I, 8	1-15	38
4	5⅔	3	V-I, 8	1-16	35
4	4⅔	3	V-I, 8	1-16	38
4	5⅓	3	V-I, 8	1-18	38
4	5	3	V-I, 9	1-16	38
4½	5	3	V-I, 9	1-16	38
4	5⅓	3	IV-I, 9	1-15	35
4	5	3	V-I, 10	1-17	37
4	5⅓	3	IV-I, 8	1-15	32 or 33
4	5⅓	3	IV-I, 8	1-15	35
4	5	3	IV-I, 8	1-15	38

Nine specimens from Dickinson Bayou give the following measurements:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4	5	3	?-I, 8	1-17	38
4	5	3	IV-I, 8	1-17	35
4	6	3	IV-I, 8	1-16	35
4	5½	3	IV-I, 9	1-16	38?
4	5⅔	3	IV-I, 9	1-17	38?
4	5½	3	IV-I, 8	1-17	38
4	5	3	IV-I, 9	1-17	38
4	5	3	IV-I, 8	1-17	38
4	5	3	IV-I, 8	1-17	38

From this table it will be seen that the dorsal-fin formula is usually IV-I, 8 or 9; or V-I, 8 or 9; never VI-I, 8 or 9, as given in the original description of this species.

XXVII.—POLYNEMIDÆ. THE THREADFINS.

132. **Polynemus octonemus** Grd. *Threadfin.* Brazos Santiago and Galveston (types, Girard, 1859, pl. X, figs. 5-9).

XXVIII.—TRICHIURIDÆ. THE HAIRTAILS.

133. **Trichiurus lepturus** L. *Silver Eel; Hairtail.* St. Joseph Island and Brazos Santiago (Girard, 1859). Galveston (Jordan & Gilbert, 1882). One specimen seen by us at Galveston.

XXIX.—CARANGIDÆ. THE PILOT-FISHES.

134. **Caranx hippos** (L.). *Horse Crevallé.* Brazos Santiago, mouth of Rio Grande (as *Carangus esculentus* types, Girard, 1859, pl. XI, figs. 1-3).

135. **Vomer setipinnis** (Mitchill). *Horsefish.* Brazos Santiago (Girard, 1859, pl. XI, fig. 8). Obtained by us at Galveston, where it does not appear to be uncommon.

136. **Selene vomer** (L.). *Moonfish.* Matamoras (as *Argyreiosus capillaris,* Girard, 1859, pl. XI, fig. 7).

137. **Chloroscombrus chrysurus** (L.). St. Joseph Island (as *Chloroscombrus caribbæus* types, Girard, 1859, pl. XI, fig. 6). Found by us at Galveston and Corpus Christi.

138. **Trachynotus carolinus** (L.). *Common Pompano.* St. Joseph Island (as *Doliodon carolinus,* Girard, 1859, pl. XI, fig. 4). Several small specimens from Galveston, the largest about 7 inches long. Head, 3¼; depth, 2⅓; D. VI-I, 24; A. II-I, 23.

139. **Oligoplites saurus** (Bloch & Schneider). *Leather-jacket; Runner.* St. Joseph Island (as *Chorinemus lanceolatus* types, Girard, 1859, pl. XI, fig. 5). Taken by us at Dickinson Bayou, Galveston, and Corpus Christi.

XXX.—APHREDODERIDÆ. THE PIRATE PERCHES.

140. **Aphredoderus sayanus** (Gilliams). *Pirate Perch.* One specimen from Neches River near Palestine, 47 from Sims Bayou near Houston, 1 from Hunter Creek, and 5 from Buffalo Bayou at Houston. The examples from Sims Bayou are unusually large, many of them being not less than 3½ inches long.

XXXI.—CENTRARCHIDÆ. THE SUNFISHES.

141. Pomoxis annularis Raf. *Crappie; "Sac-a-lait."* Long Lake and Trinity River at Magnolia Point, Neches River east of Palestine, Buffalo Bayou at Houston, and Duncan Lake and other ponds near the mouth of the Trinity River, from which it is brought to the Houston market.

142. Pomoxis sparoides (Lac.). *Calico Bass; "Sac-a-lait."* This species is brought to the Houston market in considerable numbers from San Jacinto River at Lynchburg. Both this and the crappie are known here as "sac-a-lait." Taken also by Jordan & Gilbert in Red River at Fulton, Ark.

143. Chænobryttus gulosus (C. & V.). *Warmouth; "Goggle-eye."* Leon River, Rio Medina, Dry Creek, and San Pedro Creek (as *Calliurus melanops* types, Girard, 1857, and Girard, 1858, pl. III). Rio Lampasas at Belton (Jordan & Gilbert, 1886). Long Lake, Trinity River, and Neches River near Palestine. Big White Oak Bayou, Sims Bayou, Kilper's Ponds, Hunter Creek, and Buffalo Bayou near Houston. San Jacinto River at Lynchburg, from which it is brought to the Houston market. Dickinson Bayou near Dickinson.

144. Lepomis cyanellus Raf. *Blue-spotted Sunfish.* Tributary of Gypsum Creek, headwaters of the Brazos River, headwaters of Colorado River, Red River at Fort Washita, and Rio Brazos (as *Calliurus formosus* types, Girard, 1857, and Girard, 1858, pl. V, figs. 1–4). Otter Creek, Arkansas, Rio Blanco (as *Calliurus diaphanus* types, Girard, 1857, and Girard, 1858), (as *Pomotis longulus* types, Baird & Girard, 1853, pl. XII). Rio Cibolo, a tributary of the Rio San Antonio (as *Bryttus longulus*, Baird & Girard, 1854). Rio Medina (as *Bryttus signifer* types, Girard, 1857, and Girard, 1858, pl. VII, figs. 5–8). Rio Cibolo, Mineville, Rio Seco, and the Rio Pecos (as *Calliurus longulus*, Girard, 1858, pl. V, figs. 5–8, and pl. VI, figs. 5–8). Rio Cibolo and the Minneville River (as *Calliurus longulus*, Girard, 1859, pl. IV, figs. 1–4). Red River at Fort Washita and the Rio Brazos (as *Calliurus microps* types, Girard, 1857, and Girard, 1858, pl. IV, figs. 1–4). Indianola to Nueces, Delaware Creek, and headwaters of Rio Brazos (as *Calliurus murinus* types, Girard, 1857, and Girard, 1858, pl. VII, figs. 1–4). Brownsville (as *Apomotis cyanellus*, Jordan, 1878). Trinity River at Dallas and Fort Worth (as *Apomotis cyanellus*, Cope, 1880). Rio Lampasas at Belton and Rio Colorado at Austin (Jordan & Gilbert, 1886). In the collection made by Mr. Orland Coste there are 19 specimens of this species from Spring Creek and 12 from Fulton Creek. The type of *Calliurus murinus* (U. S. N. M. No. 415) is a single specimen 6 inches long, in good condition, and labeled as coming from "near Indianola, Tex."

145. Lepomis symmetricus Forbes. Head, 2¾; depth, 2¼; eye, 3⅝; snout, 4¼; D. X–10; A. III–9; scales, 6–35–10. Body rather short and deep, the back evenly arched, a slight depression above eye; caudal peduncle stout, its least depth nearly one-half length of head. Mouth small, oblique, the maxillary reaching to vertical of eye; supplemental maxillary bone not present; 5 rows of scales on cheek; opercular process two-thirds diameter of eye, flexible margin narrow, the black not confined to the bony part. Lower pharyngeals broad, broader than in somewhat larger specimens of *L. gibbosus*, the teeth bluntly conic; gill-rakers long and slender, the longest more than half diameter of eye. Lateral line gently arched, incomplete, developed on about 14 scales only. Fins moderate, longest dorsal spine equal to distance from tip of snout to posterior edge of pupil; soft dorsal higher, its longest ray half length of head; pectorals long, 1¼ in head, reaching third anal spine; ventrals short, scarcely reaching anal, or nearly twice in head; anal, size of soft dorsal. Coloration in alcohol: Base of each scale on upper parts of body and along sides brown, outer margin pale, the general appearance resulting being that of 12 or 13 longitudinal rows of brown spots, 4 of which lie above the lateral line; on the caudal peduncle the spots are less regular; all parts of the body, including fins as well, covered thickly with small coffee-colored specks, the head and breast being especially thickly covered; tips of the ventral fins black; no black spot on dorsal or anal, and no blue lines on cheek. Compared with specimens of *Lepomis symmetricus* from New Orleans, collected by Dr. R. W. Shufeldt (U. S. N. M. No. 35213), the pharyngeal bones are somewhat narrower, the lateral line is less developed and the anal spines are longer. One specimen (U. S. N. M. No. 44830), 3 inches long, from Kilper's Pond, Houston, Tex., November 21, 1891.

146. **Lepomis miniatus** Jordan. "*Red Perch.*" Brought to the Houston market from the San Jacinto River at Lynchburg. It was also found by us in San Antonio Springs. Sides of male with about 14 rows of red spots, those of the lower rows very bright; middle of side with a few scales with black spots, and some black on scales under the pectorals; opercular flap large, broad, and dark green in color; belly orange, with red spots. Gill-rakers stout and not very short. Scales, 6-36-11; 5 rows on cheek. We have compared this species with specimens of *L. auritus* from Raleigh, N. C., and can not agree with Bollman in regarding them as being the same. It is doubtful if *L. garmani* can be separated from this species.

147. **Lepomis megalotis** (Raf.). *Long-eared Sunfish.* Rio Cibolo, tributary of the Rio San Antonio (as *Pomotis convexifrons* types, Baird & Girard, 1854). Otter Creek, Arkansas (as *Pomotis breviceps* types, Baird & Girard, 1853). Elm Creek (as *Pomotis fallax* types, Baird & Girard, 1854). Rio Cibolo and Rio Salado (as *Pomotis nefastus* types, Baird & Girard, 1854). Headwaters of Colorado River (as *Pomotis popeii* types, Girard, 1858). Headwaters of Colorado River, tributary of Red River at Fort Wachita, headwaters of Rio Brazos, and Rio Brazos (as *Pomotis breviceps*, Girard, 1858). Comanche Spring, Sans Bois Creek, tributary of Gypsum Creek, Rio Seco, Rio Medina, Rio Cibolo, Elm Creek, Rio Salado, Live Oak Creek, San Pedro Creek, and Delaware Creek (as *Pomotis fallax*, Girard, 1858, pl. VIII, figs. 9-12, pl. IX, figs. 5-12, and pl. X, figs. 1-7). Rio Cibolo, Elm Creek, Rio Salado, Live Oak Creek, and San Pedro Creek (as *Pomotis fallax*, Girard, 1859, pl. II, figs. 5-8, and pl. III, figs. 9-12). Brownsville (as *Xenotis breviceps*, Jordan, 1878.) Trinity River at Dallas and Fort Worth, Helotes Creek, Upper Medina River, and Johnson Fork of the Llano River (as *Xenotis megalotis*, Cope, 1880). Rio Lampasas at Belton, Rio Colorado, at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Long Lake, Trinity River, and Neches River near Palestine; Comal Creek and Guadalupe River at New Braunfels. San Antonio Springs at San Antonio; Big White Oak Bayou, Sims Bayou, and Buffalo Bayou near Houston; Dickinson Bayou near Dickinson; San Marcos River at San Marcos and Hunter Creek near Houston.

148. **Lepomis humilis** (Grd.). *Red-spotted Sunfish.* Brazos River (as *Bryttus humilis* types, Girard, 1857, and Girard, 1858, pl. VII, figs. 9-24). Trinity River at Fort Worth (as *Lepomis anagallinus* var., Cope, 1880). Sabine River at Longview (Jordan & Gilbert, 1886).

149. **Lepomis pallidus** (Mitchill). *Blue Sunfish.* Eagle Pass (as *Pomotis aquilensis* types, Baird & Girard, 1853). Brownsville (as *Pomotis speciosus* types, Baird & Girard, 1854). Brownsville, near Indianola, Devil River, Rio Medina, Rio Seco, New Braunfels, and Cadereita, New Leon (as *Pomotis speciosus*, Girard, 1858, pl. VIII, figs. 5-8). Brownsville and Devil River, and Cadereita, New Leon (as *Pomotis speciosus*, Girard, 1859, pl. IV, figs. 5-9). Eagle Pass, San Felipe, Rio Cibolo, Rio Nueces, Rio Sabinal, Rio Blanco, Leon River, and San Pedro near San Antonio (as *Pomotis aquilensis*, Girard, 1858, pl. IX, figs. 1-4, and pl. X, figs. 8-11). Eagle Pass, San Felipe, Rio Cibolo, Rio Nueces, and Rio Sabinal (as *Pomotis aquilensis*, Girard, 1859, pl. III, figs. 1-8). Brownsville (as *Lepiopomus pallidus*, Jordan, 1878). Llano River (as *Lepomis speciosus*, Cope, 1880). Red River at Fulton, Ark., Trinity River at Dallas, Rio Colorado at Austin, Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Fulton Creek near Creswell (Coate). Long Lake, Trinity River, and Neches River near Palestine. Kilper's Ponds and Buffalo Bayou at Houston. Dickinson Bayou near Dickinson. The type of *Pomotis aquilensis* (U. S. N. M. No. 446) is 4¼ inches, and in poor condition.

150. **Lepomis heros** (B. & G.). "*Brim.*" Rio Cibolo, a tributary of the Rio San Antonio (as *Pomotis heros* types, Baird & Girard, 1854). Rio Cibolo, Rio Nueces, Dry Creek near Victoria, Rio Blanco, Fort Bliss, N. Mex., Rio San Juan, New Leon, and near Cadereita, New Leon (as *Pomotis heros*, Girard, 1858, pl. IX, figs. 13-16). Rio Cibolo, Dry Creek near Victoria, Rio San Juan, and near Cadereita, New Leon (as *Pomotis heros*, Girard, 1859, pl. II, figs. 1-4). Specimens were obtained by us in the Houston market which had come from the San Jacinto River at Lynchburg. Life colors, dark-greenish above, gradually becoming brassy toward the belly, which is light-brassy; opercular spot greenish-black; the flap with a broad blood-red border in the male, but without it in the female; no spot on dorsal or anal. Three of the five specimens obtained from the San Jacinto River are each 7 inches in total length, and the other two are 6 inches each. The figure of this species in the report of the Mexican Boundary Survey is very poor, the depth being too great and the back too greatly arched.

151. Lepomis [illegible] (Girard). Rio Blanco and Rio [illegible] (types, Girard, [illegible] pl. V, figs. 1–4). The five [illegible] U. S. N. M. No. [illegible], [illegible] condition. [illegible]

152. Micropterus salmoides (Lac.). *Large-mouthed Black Bass.* [illegible] (as *Grystes nuecensis*, types, Baird & Girard, 1854). Rio Blanco, Rio Pecos, [illegible] Rio Medina, Rio Brazos, Rio Nueces, Rio Leona, Rio Sabinal, [illegible] River, [illegible] Creek, Live Oak Creek, Dry Creek, Turkey Creek, Elm Creek, and San Pedro Creek, San Juan River, New Leon (as *Huro nuecensis*, Girard, 1859). Rio Pecos, Rio Nueces, [illegible] Creek, Turkey Creek, Rio Leona, Elm Creek, Rio Sabinal, Dry Creek, San Pedro Creek, [illegible] River, and San Juan River, New Leon (as *Huro nuecensis*, Girard, 1859, pl. [illegible]). Trinity, Llano, Guadalupe, and Medina rivers, and Johnson Fork of [illegible] in Kimble County (as *Micropterus floridanus*, Cope, 1880). Red River at Fulton, Ark., Sabine River at Longview, Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Neches River east of Palestine. Trinity River and Long Lake at Magnolia Point. San Jacinto River at Lynchburg. Dickinson Bayou near Dickinson. Buffalo Bayou, Hunter Creek, Big White Oak Bayou near Houston. San Marcos River at San Marcos and San Antonio River at San Antonio. The large-mouthed black bass is, as the above list of localities shows, an abundant and widely distributed fish in Texas waters. It is not confined to the fresh-water streams, but is also found in brackish-water bayous. In Dickinson Bayou we found it associated with such salt or brackish water forms as oysters, shrimps, flounders, and *Sciæna ocellata*. With these were also found *Lepomis pallidus*, [illegible], *Notemigonus chrysoleucas*, *Lepisosteus platystomus*, and *Gerres gracilis*.

XXXII.—PERCIDÆ. THE DARTERS.

153. Etheostoma pellucidum clarum (Jordan & Meek). *Sand Darter.* Red River at Fulton, Ark., and Sabine River at Longview (as *Ammocrypta clara*, Jordan & Gilbert, 1886).

154. Etheostoma vivax (Hay). Sabine River at Longview (as *Ammocrypta vivax*, Jordan & Gilbert, 1886).

155. Etheostoma phlox (Cope). Trinity River near Fort Worth (as *Boleosoma phlox*, types, Cope, 1880). Trinity River (as *Claeentre phlox*, Synopsis).

156. Etheostoma chlorosoma (Hay). Three specimens of this little darter were taken in a pond on the bank of the Neches River east of Palestine, and one each in Kilper's Pond and Buffalo Bayou at Houston.

157. Etheostoma shumardi (Grd.). Red River, Fulton, Ark. (as *Cottogaster shumardi*, Jordan & Gilbert, 1886).

158. Etheostoma caprodes (Raf.). *Log Perch.* Rio Salado (as *Pileoma carbonaria* types, Baird & Girard, 1853). Rio Salado, Rio Medina, and San Pedro Creek (as *Pileoma carbonaria*, Girard, 1859, pl. VIII, figs. 10–13). Trinity River near Dallas and Llano River, Kimble County (as *Percina caprodes carbonaria*, Cope, 1880). Rio Colorado at Austin (as *Percina caprodes*, Jordan & Gilbert, 1886). Three specimens from Long Lake near Magnolia Point and one from the Neches River east of Palestine. The Long Lake specimens are quite thickly covered with larval trematodes occurring as small black specks scattered over the body with no apparent regularity, or, in other words, no one portion of the fish seems much more vulnerable than another to the attacks of this parasite. This darter is a species which frequents clear running water or clear lakes and its occurrence in such stagnant bodies of water as that of Long Lake is unusual; its being attacked by trematodes well illustrates one of the dangers which result from the transfer of any fish from clear, cool, running water to water which is more or less stagnant and impure. Active species transferred to such a pond or bayou are almost certain to suffer from the attacks of trematodes and other parasites, while those fishes which live habitually in such waters are less liable to be affected.

159. Etheostoma fasciatus (Grd.). Chihuahua River (as *Diplesion fasciatus* types, Girard, 1859).

160. Etheostoma scierum serrula (J. & G.). Sabine River at Longview (as *Hadropterus scierus serrula* var. nov. types, Jordan & Gilbert, 1886). Trinity River at Dallas, Rio Lampasas at Belton, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (as *Hadropterus scierus serrula*, Jordan & Gilbert, 1886). The present collection contains 12 specimens from

San Marcos River at San Marcos, 76 from Guadalupe River near New Braunfels, 2 from Big White Oak Bayou, 17 from Buffalo Bayou, 5 from Hunter Creek at Houston, 12 from Trinity River, and 3 from Neches River near Palestine.

161. Etheostoma lepidum (B. & G.). Upper tributaries of the Rio Nueces (as *Boleosoma lepida* types, Baird & Girard, 1853). Rio Leona (as *Pœcilichthys lepidus*, Girard, 1859, pl. VIII, figs. 14–17). Brownsville (as *Pœcilichthys lepidus*, Jordan, 1878). Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Our own collection contains 13 specimens of this darter from San Marcos River at San Marcos and 9 from Comal Creek at New Braunfels. In all of these the cheeks and opercles are entirely naked. Examination shows considerable variation in the development of the lateral line and in the number of scales on the two sides of the body. The number of scales in a longitudinal series varies from 48 to 54, and the difference between the two sides is usually 2 or 3 scales. The following tabular statement shows the variation in the 9 specimens from New Braunfels. In this table the series composing the lateral line itself is included with those designated "above the lateral line."

Series above lateral line.		Series below lateral line.		Scales in longitudinal series.			
				Right side.		Left side.	
Right side.	Left side.	Right side.	Left side.	With pores.	Without pores.	With pores.	Without pores.
7	7	9	9	36	15	35	15
7	7	9	7	32	21	31	19
7	7	7	8	34	17	35	17
7	7	8	7	32	19	32	19
7	7	8	8	20	28	27	23
7	7	8	9	32	19	35	19
7	7	8	8	32	19	33	19
6	6	7	7	34	17	34	18
7	7	8	8	32	18	31	17

162. Etheostoma lepidogenys sp. nov. Allied to *Etheostoma lepidum*. Head (including opercular flap), 4; depth, 5; eye, 4; snout, 4; dorsal, X–12; anal, II–7 or 8. Scales, 7–54 to 61–9, lateral line straight and incomplete, 32 to 38 pores. Body moderately stout, head heavy, snout short, blunt and decurved, back little elevated, caudal peduncle deep, its least depth 2 in head. Mouth rather small, but little oblique, lower jaw slightly included, premaxillary just reaching front of orbit, not protractile (*i. e.*, frenum present). Gill-membranes scarcely united. Fins moderate, soft dorsal higher than spinous portion, pectoral short, only as long as head, not reaching beyond tips of ventrals; ventrals short, distance from their tips to origin of anal equals half length of head; anal rather small, scarcely reaching tips of soft dorsal when depressed. Scales strongly ctenoid, cheeks densely scaled, opercles and breast entirely naked, nape scaled; median line of belly with ordinary scales, not deciduous. In the larger specimen, which is 2 inches long, there are on the right side 57 scales in a longitudinal series, upon 38 of which pores are developed, while upon the left side there are but 54 scales, upon 35 of which pores are developed. The second specimen, 1¾ inches long, has 61 scales upon the right side with pores in 38 of them, and 55 upon the left with only 35 developed pores. This shows a considerable variation, not only among individuals, but between the two sides of the same individual. Color in alcohol: Head dark above, sides pale, a dark line forward from eye to tip of snout and another broader one straight downward from the eye, broadest at lower end; a dark postocular spot followed by a fainter one on the opercle; dark humeral scale present; side of body with about 13 dark vertical bars, the first crossing over the back just in front of the spinous dorsal, the next four indistinct except on back where they widen into large blotches, the sixth crossing the back between the two dorsals; the seventh to tenth, inclusive, are under the soft dorsal; the eleventh crosses just back of it, while the thirteenth is at the base of the caudal fin; spinous dorsal pale at base, next a broad dark band, then a narrow pale one which is followed by a pale blue one, probably blue in life, and lastly the fin is tipped with a very narrow margin of white; soft dorsal marbled or vermiculated with brown, the largest,

151. Lepomis albulus (Girard). Rio Blanco (as *Bryttus albulus* types, Girard, 1857, and Girard, 1858, pl. VI, figs. 1–4). The type (U. S. N. M. No. 421) is 7 inches long and in excellent condition. Head, 2¾; depth, 2⅜; eye, 4¼; snout, 3¼; scales, 7–42–12, 5 rows on cheek.

152. Micropterus salmoides (Lac.). *Big-mouthed Black Bass; "Trout."* Rio Frio and Rio Nueces (as *Grystes nuecensis* types, Baird & Girard, 1854). Rio Blanco, Rio Frio, Rio Leon, Rio Seco, Rio Medina, Rio Brazos, Rio Nueces, Rio Leona, Rio Sabinal, Minneville River, Delaware Creek, Live Oak Creek, Dry Creek, Turkey Creek, Elm Creek, and San Pedro Creek; San Juan River, New Leon (as *Dioplites nuecensis*, Girard, 1858). Rio Frio, Rio Nueces, Live Oak Creek, Turkey Creek, Rio Leona, Elm Creek, Rio Sabinal, Dry Creek, San Pedro Creek, Minneville River, and San Juan River, New Leon (as *Dioplites nuecensis*, Girard, 1859, pl. I). Trinity, Llano, Guadalupe, and Medina rivers, and Johnson Fork of Llano River in Kimble County (as *Micropterus floridanus*, Cope, 1880). Red River at Fulton, Ark., Sabine River at Longview, Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Neches River east of Palestine, Trinity River and Long Lake at Magnolia Point, San Jacinto River at Lynchburg, Dickinson Bayou near Dickinson, Buffalo Bayou, Hunter Creek, Big White Oak Bayou near Houston, San Marcos River at San Marcos, and San Antonio River at San Antonio. The big-mouthed black bass is, as the above list of localities shows, an abundant and widely distributed fish in Texan waters. It is not confined to the fresh-water streams, but is also found in brackish-water bayous. In Dickinson Bayou we found it associated with such salt or brackish water forms as oysters, shrimps, flounders, and *Sciæna ocellata*. With these were also found *Lepomis pallidus*, *Ictiobus cyprinella*, *Notemigonus chrysoleucus*, *Lepisosteus platystomus*, and *Gerres gracilis*.

XXXII.—PERCIDÆ. THE DARTERS.

153. Etheostoma pellucidum clarum (Jordan & Meek). *Sand Darter*. Red River at Fulton, Ark., and Sabine River at Longview (as *Ammocrypta clara*, Jordan & Gilbert, 1886).

154. Etheostoma vivax (Hay). Sabine River at Longview (as *Ammocrypta vivax*, Jordan & Gilbert, 1886).

155. Etheostoma phlox (Cope). Trinity River near Fort Worth (as *Boleosoma phlox* types, Cope, 1880). Trinity River (as *Ulocentra phlox*, Synopsis).

156. Etheostoma chlorosoma (Hay). Three specimens of this little darter were taken in a pond on the bank of the Neches River east of Palestine, and one each in Kilper's Pond and Buffalo Bayou at Houston.

157. Etheostoma shumardi (Grd.). Red River, Fulton, Ark. (as *Cottogaster shumardi*, Jordan & Gilbert, 1886).

158. Etheostoma caprodes (Raf.). *Log Perch*. Rio Salado (as *Pileoma carbonaria* types, Baird & Girard, 1853). Rio Salado, Rio Medina, and San Pedro Creek (as *Pileoma carbonaria*, Girard, 1859, pl. VIII, figs. 10–13). Trinity River near Dallas and Llano River, Kimble County (as *Percina caprodes carbonaria*, Cope, 1880). Rio Colorado at Austin (as *Percina caprodes*, Jordan & Gilbert, 1886). Three specimens from Long Lake near Magnolia Point and one from the Neches River east of Palestine. The Long Lake specimens are quite thickly covered with larval trematodes occurring as small black specks scattered over the body with no apparent regularity, or, in other words, no one portion of the fish seems much more vulnerable than another to the attacks of this parasite. This darter is a species which frequents clear running water or clear lakes and its occurrence in such stagnant bodies of water as that of Long Lake is unusual; its being attacked by trematodes well illustrates one of the dangers which result from the transfer of any fish from clear, cool, running water to water which is more or less stagnant and impure. Active species transferred to such a pond or bayou are almost certain to suffer from the attacks of trematodes and other parasites, while those fishes which live habitually in such waters are less liable to be affected.

159. Etheostoma fasciatus (Grd.). Chihuahua River (as *Diplesion fasciatus* types, Girard, 1859*b*).

160. Etheostoma scierum serrula (J. & G.). Sabine River at Longview (as *Hadropterus scierus serrula* var. nov. types, Jordan & Gilbert, 1886). Trinity River at Dallas, Rio Lampasas at Belton, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (as *Hadropterus scierus serrula*, Jordan & Gilbert, 1886). The recent collection contains 42 specimens from lateral line. A young specimen, 4⅝ inches long, has the head, 3; depth, 2¾; D. XIII–13; A. III–12; scales, about 55 with pores; eye large, 3⅛ in head, and greater than the interorbital width.

176. **Lagodon rhomboides** (L.). *Pinfish; Chopa Spina.* Brazos, Indianola, St. Joseph Island, and Brazos Santiago (Girard, 1859, pl. IX, figs. 13–16). Galveston (Jordan & Gilbert, 1882). Galveston and Corpus Christi, at both of which places it is an abundant species.

177. **Archosargus probatocephalus** (Walb.). *Sheepshead.* Indianola and Brazos Santiago (as *Sargus ovis*, Girard, 1859). Galveston and Corpus Christi.

XXXV.—SCIÆNIDÆ. THE CROAKERS.

178. **Aplodinotus grunniens** Raf. *Fresh-water Drum.* Mouth of Rio Grande and Matamoras (as *Amblodon neglectus* types, Girard, 1859, pl. V, figs. 6–10). Red River at Fulton, Ark., and Rio Colorado at Austin (Jordan & Gilbert, 1886). Numerous specimens seen in the Houston market, from the mouth of the Trinity River.

179. **Pogonias chromis** (L.). *Salt-water Drum.* Galveston (Jordan & Gilbert, 1882). Found by us at Galveston, but not seen at Corpus Christi. Brazos Santiago (as *Pogonias fasciatus*, Girard, 1859).

180. **Stelliferus lanceolatus** (Holbrook). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859).

181. **Bairdiella chrysura** (Lac.). *Yellow-tail.* Galveston (as *Sciæna punctata*, Jordan & Gilbert, 1882). A dozen specimens were obtained by us at Corpus Christi, where it is an abundant fish.

182. **Sciæna ocellata** (L.). *Redfish; Channel Bass.* Indianola (as *Johnius ocellatus*, Girard, 1859, pl. VIII, figs. 1–4). Galveston (Jordan & Gilbert, 1882). An abundant and important food-fish at Galveston and Corpus Christi. Specimens 38 and 39 inches in length at Galveston weighed 46 pounds each. In the Houston market this fish was selling at 10 cents a pound. Dickinson Bayou.

183. **Leiostomus xanthurus** Lac. *Spot; Goody.* Brazos Santiago and Indianola (as *Leiostomus obliquus*, Girard, 1859). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859). Brazos Santiago and St. Joseph Island (as *Homoprion xanthurus*, Girard, 1859). Galveston (Jordan & Gilbert, 1882). Found by us both at Galveston and Corpus Christi.

184. **Larimus fasciatus** (Holbrook). Eleven small examples, 2 to 4½ inches long, were obtained at Galveston.

185. **Micropogon undulatus** (L.). *Croaker.* Mouth of the Rio Grande, Indianola, St. Joseph Island, and Galveston (Girard, 1859, pl. VII). Galveston (Jordan & Gilbert, 1882). Taken by us only at Galveston.

186. **Menticirrhus littoralis** (Holbrook). *Surf Whiting.* Galveston (Jordan & Gilbert, 1882). A single small specimen gotten by us at Galveston.

187. **Menticirrhus americanus** (L.). *Whiting.* Indianola and Brazos Santiago (as *Umbrina phalæna* types, Girard, 1859, pl. V, figs. 1–5). Galveston (as *Menticirrus alburnus*, Jordan & Gilbert, 1882). One specimen in the collection from Galveston. Each of these two species is common, however, at Galveston, and will doubtless be found all along the Texas coast.

188. **Cynoscion nothus** (Holbrook). Brazos Santiago (as *Otolithus nothus*, Girard, 1859).

189. **Cynoscion nebulosus** (C. & V.). *Spotted Sea Trout.* Brazos Santiago, Brazos, and Indianola (as *Otolithus drummondi*, Girard, 1859, pl. VI). Galveston (Jordan & Gilbert, 1882). Corpus Christi and Galveston. Also seen in the Houston market from the mouth of Trinity River.

XXXVI.—GERRIDÆ. THE GERROIDS.

190. **Gerres gula** (C. & V.). Brazos Santiago, Brazos, Indianola, and St. Joseph Island (as *Encinostomus argenteus*, Girard, 1859, pl. IX, figs. 9–12). Taken by us only at Corpus Christi.

191. **Gerres gracilis** (Gill). There are in the present collection fourteen specimens representing Corpus Christi, Galveston, Dickinson Bayou, and Buffalo Bayou at Houston. This last locality is 60 miles from salt water.

XXXVII.—CICHLIDÆ. THE CICHLIDS.

192. **Heros cyanoguttatus** (B. & G.). Fresh water at Brownsville (as *Heros cyanoguttatus* types, Baird & Girard, 1854). Lagoon at Fort Brown, Brownsville, Matamoras, San Juan River, and Cadereita, New Leon, and Devil River (as *Herichthys cyanoguttatus*, Girard, 1859, pl. IV, figs. 9–12). The type of this species (U. S. N. M. No. 851) is about 6 inches in total length and is in excellent condition. It is well described in Jordan & Gilbert's Synopsis.

193. **Heros pavonaceus** Garman. Mondova, Coahuila (types, Garman, 1881, and Synopsis). This and the preceding species are the most northern representatives of the *Cichlidæ*, a family represented in Central and South America by many species.

XXXVIII.—EPHIPPIDÆ. THE ANGEL-FISHES.

194. **Chætodipterus faber** (Broussonet). *Angel-fish.* Galveston (Jordan & Gilbert, 1882). Two small specimens obtained by us at Galveston.

XXXIX.—GOBIIDÆ. THE GOBIES.

195. **Gobiomorus dormitator** (Bl. & Sch.). Near mouth of the Rio Grande (as *Philipnus dormitator*, Girard, 1859, pl. XII, fig. 13).

196. **Dormitator maculatus** (Bloch). Near mouth of the Rio Grande (as *Eleotris gyrinus*, Girard, 1859, pl. XII, figs. 11 and 12, and *Eleotris sumnulentus* types, Girard, 1859, pl. XII, figs. 1–3). We obtained two small specimens at Galveston in Galveston Bay.

197. **Gobius lyricus** Girard. Brazos Santiago (types, Girard, 1858 and 1859, pl. XII, figs. 4 and 5). Galveston (Jordan & Gilbert, 1882). Rio Grande (as *Euctenogobius lyricus*, Synopsis). Taken by us at Galveston.

198. **Gobius soporator** C. & V. *Goby.* St. Joseph Island (as *Gobius catulus* types, Girard, 1859, pl. XII, figs. 9 and 10). St. Joseph Island (as *Evorthodus catulus*, Synopsis).

199. **Gobius boleosoma** J. & G. *Goby.* Several specimens obtained by us at Galveston, Dickinson Bayou, and at Corpus Christi, from which the following description is taken: Head, 4 to 4⅗; depth, 3 to 4; D. VI–11 or 12 to VI–13 or 14; A. 11 to 13 or 14. Scales 26 to 31. Body slender, compressed. Head moderate; snout evenly decurved, equal to eye. Eye, 3 to 4 in head, its diameter about equal to the interorbital space. Mouth moderate; maxillary extending slightly beyond point of orbit. Teeth slender in several rows. Scales moderate, ctenoid, those in front somewhat reduced. Vertical fins low, caudal pointed, nearly as long as head; pectoral shorter than caudal; ventral shorter than caudal. Region before dorsal and breast naked; belly scaly. Color, light olivaceous, faintly mottled with darker; along the middle of side are four or five oblong dark blotches, the last being at base of caudal; a jet-black spot above gill-opening on side of back; head faintly marked above with darker; a dark bar extending from near angle of mouth nearly to edge of preopercle; also a dark bar from maxillary to lower front of eye; opercle dusky with silvery edge; vertical fins and caudal barred with darker; ventral pale, with two dark lines through the middle; in some cases dark with pale margin; head and naked areas punctulate with darker. Other specimens with no shoulder spots, no dark punctulations on breast, and ventrals with no dark markings. Spots on the sides of all the specimens range from linear to nearly round. In their review of the *Gobiidæ*, Jordan & Eigenmann, Proc. U. S. Nat. Mus. 1886, 490, state that the breast, nape, and belly of this species are naked, but in our specimens, as well as in some other specimens identified by Dr. Jordan, and with which our specimens were compared, the belly is always evidently scaly, as also the belly of *G. stigmaticus*, which was said to be naked. The thinness and transparency of the scales on the belly cause it to appear naked in some specimens.

The following table gives measurements of 14 specimens:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4¼	5⅕	4	VI-11 or 12	11	30
4	5⅓	4	VI-11	11	30 or 31
4	4¾	3⅔	VI-12 or 13	13 or 14	30 or 31
4	5⅞	4	VI-11 or 12	12	30 or 31
4⅔	5⅕	4	VI-11 or 12	11 or 12	30 or 31
4⅔	5⅓	3⅔	VI-11 or 12	13 or 14	....
4¼	5	4	VI-11	11	30 or 31
4⅔	4⅔	4, nearly.	VI-11	11	29 or 30
4⅔	5⅓	3⅔	VI-11	12	30, about.
4+	5⅓	4	VI-11	11	28 or 29
4	5⅓	4+	VI-11	11	28 or 29
4	5+	4	VI-11	12	26, about.
4+	5⅔	3½	VI-11	11	28
4	5⅔	3+	VI-?	11	29 or 30

200. **Gobius würdemanni** Grd. Brazos Santiago (types, Girard, 1859, and Synopsis).

201. **Gobionellus oceanicus** (Pallas). *Emerald Fish.* St. Joseph Island (as *Gobionellus hastatus* types, Girard, 1859, pl. XII, figs. 7 and 8).

202. **Lepidogobius gulosus** (Grd.). *Goby.* Indianola (as *Gobius gulosus* types, Girard, 1858 and 1859, and Synopsis). Taken by us at Corpus Christi and in Dickinson Bayou near Dickinson.

203. **Gobiosoma bosci** (Lac.). *Goby.* Five specimens from Galveston and nineteen from Corpus Christi.

204. **Gobiosoma molestum** Grd. *Goby.* Indianola (type, Girard, 1859, pl. XII, fig. 14). Six specimens are in our collection from Corpus Christi.

XL.—TRIGLIDÆ. THE GURNARDS.

205. **Prionotus scitulus** J. & G. *Sea Robin.* Taken by us only at Galveston.

206. **Prionotus tribulus** C. & V. *Sea Robin.* Galveston (Jordan & Gilbert, 1882). Taken by us at Galveston and Corpus Christi.

XLI.—GOBIESOCIDÆ.

207. **Gobiesox virgatulus** J. & G. One specimen, 1⅞ inches long to tip of caudal, taken at Galveston. Head (from tip of snout to edge of gill-cover), about 2⅞; width of head, 3¼; depth, 7¼; D. 10; A. 6. Body slender, head low and broad. Eye small, 4¼ in head or 2 in interorbital width. Cheeks not prominent; opercle ending in a sharp spine; cleft of mouth extending below front of orbit; teeth of upper jaw in two series, the outer series short, those occupying front of jaw enlarged, four of which are canine-like. Eight middle teeth of lower jaw incisor-like, edges entire. Color, dark olivaceous, indistinctly mottled and finely punctate; under part of head, disk, and ventrals pale and yellowish; dorsal, caudal, and anal dark, barred with paler; belly yellowish brown. This specimen seems to be *G. virgatulus*, but the fin rays are fewer than in that species.

XLII.—BATRACHIDÆ. THE TOADFISHES.

208. **Batrachus tau** (L.). *Toadfish; Oyster-fish.* Indianola (Girard, 1859). One example obtained by us at Corpus Christi.

209. **Porichthys porosissimus** (C. & V.). Galveston (as *Porichthys plectrodon* types, Jordan & Gilbert, 1882).

XLIII.—URANOSCOPIDÆ. THE STAR-GAZERS.

210. **Upsilonphorus y-græcum** (C. & V.). *Star-gazer.* One specimen of this species was secured by us at Galveston.

211. **Astroscopus anoplos** (C. & V.). *Dogfish. Electric Dogfish.* Galveston (Jordan & Gilbert, 1882), where they report it as being rather common.

XLIV—BLENNIIDÆ. THE BLENNIES.

212. **Chasmodes bosquianus** (Lac.). *Blenny*. Three specimens obtained by us at Corpus Christi.

213. **Isesthes hentzi** (Le S.). *Blenny*. We collected two specimens at Corpus Christi.

214. **Isesthes ionthas** J. & G. *Blenny*. Apparently not common on the Texas coast, as it has not hitherto been reported from that coast and we obtained but a single specimen at Galveston.

215. **Isesthes scrutator** J. & G. *Blenny*. Galveston (types, Jordan & Gilbert, 1882).

216. **Hypleurochilus geminatus** (Wood). *Blenny*. St. Joseph Island (as *Blennius multifilus* types, Girard, 1859, pl. xii, fig. 6).

XLV.—OPHIDIIDÆ. THE OPHIDIOIDS.

217. **Ophidion marginatum** DeKay. St. Joseph Island (as *Ophidion josephi* types, Girard, 1859, and Synopsis).

XLVI.—PLEURONECTIDÆ. THE FLOUNDERS.

218. **Citharichthys spilopterus** Günther *Flounder*. Taken by us at Galveston.

219. **Etropus crossotus** J. & G. Galveston (Jordan & Gilbert, 1882). Ten specimens obtained by us at Galveston.

220. **Paralichthys lethostigma** J. & G. *Flounder*. A common market fish at Galveston (as *Paralichthys dentatus*, Jordan & Gilbert, 1882). Found by us at Galveston, Dickinson Bayou, and Corpus Christi.

221. **Ancylopsetta quadrocellata** Gill. We have two small specimens taken at Galveston.

222. **Achirus fasciatus** Lac. Galveston (as *Achirus lineatus browni*, Jordan & Gilbert, 1882). One young individual from Galveston and another from Dickinson Bayou near Dickinson.

223. **Symphurus plagiusa** (L.). Found by us at Galveston, Dickinson Bayou, and Corpus Christi. It does not appear at all abundant, as we obtained but four specimens.

XLVII.—ANTENNARIIDÆ. THE FROGFISHES.

224. **Pterophryne histrio** (L.). Galveston (as *Pterophrynoides histrio*, Jordan & Gilbert, 1882). One specimen from Galveston, presented to us by Dr. A. Galny.

XLVIII.—MALTHIDÆ. THE BATFISHES.

225. **Malthe vespertilio** (L.). A specimen of this fish was given to Dr. Jordan by Dr. A. Galny, of Galveston (Jordan & Gilbert, 1882).

XLIX.—OSTRACIIDÆ. THE TRUNKFISHES.

226. **Ostracion tricorne** L. *Cowfish*. Galveston, one specimen (as *Ostracium quadricorne*, Jordan & Gilbert, 1882).

L.—BALISTIDÆ. THE TRIGGER-FISHES.

227. **Alutera schœpfii** (Walb.). *Orange Filefish*. Through the kindness of Mr. J. A. Singley, of the Texas Geological Survey, we have received a dry skin of this species. Mr. Singley obtained the specimen at Galveston, where it is known as the "orange filefish." A young fish, probably of this species, was seen by Dr. Jordan at Galveston (as *Alutera* sp. incog., Jordan & Gilbert, 1882).

LI.—TETRODONTIDÆ. THE PUFFERS.

228. **Lagocephalus lævigatus** (L.). One specimen obtained by Dr. Jordan at Galveston (Jordan & Gilbert, 1882).

229. **Tetrodon nephelus** (Goode & Bean). *Swellfish; Puffer*. Abundant at Galveston (as *Tetrodon turgidus nephelus*, Jordan & Gilbert, 1882). One specimen taken by us at Galveston and one at Corpus Christi.

230. **Chilomycterus schœpfii** (Walb.). Common about Galveston (Jordan & Gilbert, 1882).

lateral line. A young specimen, 4⅗ inches long, has the head, 3; depth, 2⅔; D. XIII-13; A. III-12; scales, about 55 with pores; eye large, 3⅓ in head, and greater than the interorbital width.

176. **Lagodon rhomboides** (L.). *Pinfish; Chopa Spina.* Brazos, Indianola, St. Joseph Island, and Brazos Santiago (Girard, 1859, pl. IX, figs. 13-16). Galveston (Jordan & Gilbert, 1882). Galveston and Corpus Christi, at both of which places it is an abundant species.

177. **Archosargus probatocephalus** (Walb.). *Sheepshead.* Indianola and Brazos Santiago (as *Sargus ovis*, Girard, 1859). Galveston and Corpus Christi.

XXXV.—SCIÆNIDÆ. THE CROAKERS.

178. **Aplodinotus grunniens** Raf. *Fresh-water Drum.* Mouth of Rio Grande and Matamoras (as *Amblodon neglectus* types, Girard, 1859, pl. V, figs. 6-10). Red River at Fulton, Ark., and Rio Colorado at Austin (Jordan & Gilbert, 1886). Numerous specimens seen in the Houston market, from the mouth of the Trinity River.

179. **Pogonias chromis** (L.). *Salt-water Drum.* Galveston (Jordan & Gilbert, 1882). Found by us at Galveston, but not seen at Corpus Christi. Brazos Santiago (as *Pogonias fasciatus*, Girard, 1859).

180. **Stelliferus lanceolatus** (Holbrook). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859).

181. **Bairdiella chrysura** (Lac.). *Yellow-tail.* Galveston (as *Sciæna punctata*, Jordan & Gilbert, 1882). A dozen specimens were obtained by us at Corpus Christi, where it is an abundant fish.

182. **Sciæna ocellata** (L.). *Redfish; Channel Bass.* Indianola (as *Johnius ocellatus*, Girard, 1859, pl. VIII, figs. 1-4). Galveston (Jordan & Gilbert, 1882). An abundant and important food-fish at Galveston and Corpus Christi. Specimens 38 and 39 inches in length at Galveston weighed 46 pounds each. In the Houston market this fish was selling at 10 cents a pound. Dickinson Bayou.

183. **Leiostomus xanthurus** Lac. *Spot; Goody.* Brazos Santiago and Indianola (as *Leiostomus obliquus*, Girard, 1859). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859). Brazos Santiago and St. Joseph Island (as *Homoprion xanthurus*, Girard, 1859). Galveston (Jordan & Gilbert, 1882). Found by us both at Galveston and Corpus Christi.

184. **Larimus fasciatus** (Holbrook). Eleven small examples, 2 to 4½ inches long, were obtained at Galveston.

185. **Micropogon undulatus** (L.). *Croaker.* Mouth of the Rio Grande, Indianola, St. Joseph Island, and Galveston (Girard, 1859, pl. VII). Galveston (Jordan & Gilbert, 1882). Taken by us only at Galveston.

186. **Menticirrhus littoralis** (Holbrook). *Surf Whiting.* Galveston (Jordan & Gilbert, 1882). A single small specimen gotten by us at Galveston.

187. **Menticirrhus americanus** (L.). *Whiting.* Indianola and Brazos Santiago (as *Umbrina phalæna* types, Girard, 1859, pl. V, figs. 1-5). Galveston (as *Menticirrus alburnus*, Jordan & Gilbert, 1882). One specimen in the collection from Galveston. Each of these two species is common, however, at Galveston, and will doubtless be found all along the Texas coast.

188. **Cynoscion nothus** (Holbrook). Brazos Santiago (as *Otolithus nothus*, Girard, 1859).

189. **Cynoscion nebulosus** (C. & V.). *Spotted Sea Trout.* Brazos Santiago, Brazos, and Indianola (as *Otolithus drummondi*, Girard, 1859, pl. VI). Galveston (Jordan & Gilbert, 1882). Corpus Christi and Galveston. Also seen in the Houston market from the mouth of Trinity River.

XXXVI.—GERRIDÆ. THE GERROIDS.

190. **Gerres gula** (C. & V.). Brazos Santiago, Brazos, Indianola, and St. Joseph Island (as *Encinostomus argenteus*, Girard, 1859, pl. IX, figs. 9-12). Taken by us only at Corpus Christi.

191. **Gerres gracilis** (Gill). There are in the present collection fourteen specimens representing Corpus Christi, Galveston, Dickinson Bayou, and Buffalo Bayou at Houston. This last locality is 60 miles from salt water.

XXXVII.—CICHLIDÆ. THE CICHLIDS.

192. **Heros cyanoguttatus** (B. & G.). Fresh water at Brownsville (as *Heros cyanoguttatus* types, Baird & Girard, 1854). Lagoon at Fort Brown, Brownsville, Matamoras, San Juan River, and Cadereita, New Leon, and Devil River (as *Herichthys cyanoguttatus*, Girard, 1859, pl. IV, figs. 9–12). The type of this species (U. S. N. M. No. 851) is about 6 inches in total length and is in excellent condition. It is well described in Jordan & Gilbert's Synopsis.

193. **Heros pavonaceus** Garman. Mondova, Coahuila (types, Garman, 1881, and Synopsis). This and the preceding species are the most northern representatives of the *Cichlidæ*, a family represented in Central and South America by many species.

XXXVIII.—EPHIPPIDÆ. THE ANGEL-FISHES.

194. **Chætodipterus faber** (Broussonet). *Angel-fish.* Galveston (Jordan & Gilbert, 1882). Two small specimens obtained by us at Galveston.

XXXIX.—GOBIIDÆ. THE GOBIES.

195. **Gobiomorus dormitator** (Bl. & Sch.). Near mouth of the Rio Grande (as *Philipnus dormitator*, Girard, 1859, pl. XII, fig. 13).

196. **Dormitator maculatus** (Bloch). Near mouth of the Rio Grande (as *Eleotris gyrinus*, Girard, 1859, pl. XII, figs. 11 and 12, and *Eleotris sumnulentus* types, Girard, 1859, pl. XII, figs. 1–3). We obtained two small specimens at Galveston in Galveston Bay.

197. **Gobius lyricus** Girard. Brazos Santiago (types, Girard, 1858 and 1859, pl. XII, figs. 4 and 5). Galveston (Jordan & Gilbert, 1882). Rio Grande (as *Euctenogobius lyricus*, Synopsis). Taken by us at Galveston.

198. **Gobius soporator** C. & V. *Goby.* St. Joseph Island (as *Gobius catulus* types, Girard, 1859, pl. XII, figs. 9 and 10). St. Joseph Island (as *Evorthodus catulus*, Synopsis).

199. **Gobius boleosoma** J. & G. *Goby.* Several specimens obtained by us at Galveston, Dickinson Bayou, and at Corpus Christi, from which the following description is taken: Head, 4 to 4⅗; depth, 3 to 4; D. VI–11 or 12 to VI–13 or 14; A. 11 to 13 or 14. Scales 26 to 31. Body slender, compressed. Head moderate; snout evenly decurved, equal to eye. Eye, 3 to 4 in head, its diameter about equal to the interorbital space. Mouth moderate; maxillary extending slightly beyond point of orbit. Teeth slender in several rows. Scales moderate, ctenoid, those in front somewhat reduced. Vertical fins low, caudal pointed, nearly as long as head; pectoral shorter than caudal; ventral shorter than caudal. Region before dorsal and breast naked; belly scaly. Color, light olivaceous, faintly mottled with darker; along the middle of side are four or five oblong dark blotches, the last being at base of caudal; a jet-black spot above gill-opening on side of back; head faintly marked above with darker; a dark bar extending from near angle of mouth nearly to edge of preopercle; also a dark bar from maxillary to lower front of eye; opercle dusky with silvery edge; vertical fins and caudal barred with darker; ventral pale, with two dark lines through the middle; in some cases dark with pale margin; head and naked areas punctulate with darker. Other specimens with no shoulder spots, no dark punctulations on breast, and ventrals with no dark markings. Spots on the sides of all the specimens range from linear to nearly round. In their review of the *Gobiidæ*, Jordan & Eigenmann, Proc. U. S. Nat. Mus. 1886, 490, state that the breast, nape, and belly of this species are naked, but in our specimens, as well as in some other specimens identified by Dr. Jordan, and with which our specimens were compared, the belly is always evidently scaly, as also the belly of *G. stigmaticus*, which was said to be naked. The thinness and transparency of the scales on the belly cause it to appear naked in some specimens.

The following table gives measurements of 14 specimens:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4¼	5⅕	4	VI-11 or 12	11	30
4	5⅓	4	VI-11	11	30 or 31
4	4¾	3½	VI-12 or 13	13 or 14	30 or 31
4	5⅞	4	VI-11 or 12	12	30 or 31
4⅔	5⅔	4	VI-11 or 12	11 or 12	30 or 31
4⅓	5⅓	3½	VI-11 or 12	13 or 14	....
4¼	5	4	VI-11	11	30 or 31
4⅔	4⅔	4, nearly.	VI-11	11	29 or 30
4⅔	5⅓	3½	VI-11	12	30, about.
4+	5⅓	4	VI-11	11	28 or 29
4	5⅓	4+	VI-11	11	28 or 29
4	5+	4	VI-11	12	26, about.
4+	5⅔	3⅓	VI-11	11	28
4	5⅔	3+	VI-?	11	29 or 30

200. Gobius würdemanni Grd. Brazos Santiago (types, Girard, 1859, and Synopsis).

201. Gobionellus oceanicus (Pallas). *Emerald Fish.* St. Joseph Island (as *Gobionellus hastatus* types, Girard, 1859, pl. XII, figs. 7 and 8).

202. Lepidogobius gulosus (Grd.). *Goby.* Indianola (as *Gobius gulosus* types, Girard, 1858 and 1859, and Synopsis). Taken by us at Corpus Christi and in Dickinson Bayou near Dickinson.

203. Gobiosoma bosci (Lac.). *Goby.* Five specimens from Galveston and nineteen from Corpus Christi.

204. Gobiosoma molestum Grd. *Goby.* Indianola (type, Girard, 1859, pl. XII, fig. 14). Six specimens are in our collection from Corpus Christi.

XL.—TRIGLIDÆ. THE GURNARDS.

205. Prionotus scitulus J. & G. *Sea Robin.* Taken by us only at Galveston.

206. Prionotus tribulus C. & V. *Sea Robin.* Galveston (Jordan & Gilbert, 1882). Taken by us at Galveston and Corpus Christi.

XLI.—GOBIESOCIDÆ.

207. Gobiesox virgatulus J. & G. One specimen, 1⅝ inches long to tip of caudal, taken at Galveston. Head (from tip of snout to edge of gill-cover), about 2⅞; width of head, 3¼; depth, 7¼; D. 10; A. 6. Body slender, head low and broad. Eye small, 4½ in head or 2 in interorbital width. Cheeks not prominent; opercle ending in a sharp spine; cleft of mouth extending below front of orbit; teeth of upper jaw in two series, the outer series short, those occupying front of jaw enlarged, four of which are canine-like. Eight middle teeth of lower jaw incisor-like, edges entire. Color, dark olivaceous, indistinctly mottled and finely punctate; under part of head, disk, and ventrals pale and yellowish; dorsal, caudal, and anal dark, barred with paler; belly yellowish brown. This specimen seems to be *G. virgatulus*, but the fin rays are fewer than in that species.

XLII.—BATRACHIDÆ. THE TOADFISHES.

208. Batrachus tau (L.). *Toadfish; Oyster-fish.* Indianola (Girard, 1859). One example obtained by us at Corpus Christi.

209. Porichthys porosissimus (C. & V.). Galveston (as *Porichthys plectrodon* types, Jordan & Gilbert, 1882).

XLIII.—URANOSCOPIDÆ. THE STAR-GAZERS.

210. Upsilonphorus y-græcum (C. & V.). *Star-gazer.* One specimen of this species was secured by us at Galveston.

211. Astroscopus anoplos (C. & V.). *Dogfish. Electric Dogfish.* Galveston (Jordan & Gilbert, 1882), where they report it as being rather common.

XLIV—BLENNIIDÆ. THE BLENNIES.

212. **Chasmodes bosquianus** (Lac.). *Blenny*. Three specimens obtained by us at Corpus Christi.
213. **Isesthes hentzi** (Le S.). *Blenny*. We collected two specimens at Corpus Christi.
214. **Isesthes ionthas** J. & G. *Blenny*. Apparently not common on the Texas coast, as it has not hitherto been reported from that coast and we obtained but a single specimen at Galveston.
215. **Isesthes scrutator** J. & G. *Blenny*. Galveston (types, Jordan & Gilbert, 1882).
216. **Hypleurochilus geminatus** (Wood). *Blenny*. St. Joseph Island (as *Blennius multifilus* types, Girard, 1859, pl. XII, fig. 6).

XLV.—OPHIDIIDÆ. THE OPHIDIOIDS.

217. **Ophidion marginatum** DeKay. St. Joseph Island (as *Ophidion josephi* types, Girard, 1859, and Synopsis).

XLVI.—PLEURONECTIDÆ. THE FLOUNDERS.

218. **Citharichthys spilopterus** Günther *Flounder*. Taken by us at Galveston.
219. **Etropus crossotus** J. & G. Galveston (Jordan & Gilbert, 1882). Ten specimens obtained by us at Galveston.
220. **Paralichthys lethostigma** J. & G. *Flounder*. A common market fish at Galveston (as *Paralichthys dentatus*, Jordan & Gilbert, 1882). Found by us at Galveston, Dickinson Bayou, and Corpus Christi.
221. **Ancylopsetta quadrocellata** Gill. We have two small specimens taken at Galveston.
222. **Achirus fasciatus** Lac. Galveston (as *Achirus lineatus browni*, Jordan & Gilbert, 1882). One young individual from Galveston and another from Dickinson Bayou near Dickinson.
223. **Symphurus plagiusa** (L.). Found by us at Galveston, Dickinson Bayou, and Corpus Christi. It does not appear at all abundant, as we obtained but four specimens.

XLVII.—ANTENNARIIDÆ. THE FROGFISHES.

224. **Pterophryne histrio** (L.). Galveston (as *Pterophrynoides histrio*, Jordan & Gilbert, 1882). One specimen from Galveston, presented to us by Dr. A. Galny.

XLVIII.—MALTHIDÆ. THE BATFISHES.

225. **Malthe vespertilio** (L.). A specimen of this fish was given to Dr. Jordan by Dr. A. Galny, of Galveston (Jordan & Gilbert, 1882).

XLIX.—OSTRACIIDÆ. THE TRUNKFISHES.

226. **Ostracion tricorne** L. *Cowfish*. Galveston, one specimen (as *Ostracium quadricorne*, Jordan & Gilbert, 1882).

L.—BALISTIDÆ. THE TRIGGER-FISHES.

227. **Alutera schœpfii** (Walb.). *Orange Filefish*. Through the kindness of Mr. J. A. Singley, of the Texas Geological Survey, we have received a dry skin of this species. Mr. Singley obtained the specimen at Galveston, where it is known as the "orange filefish." A young fish, probably of this species, was seen by Dr. Jordan at Galveston (as *Alutera* sp. incog., Jordan & Gilbert, 1882).

LI.—TETRODONTIDÆ. THE PUFFERS.

228. **Lagocephalus lævigatus** (L.). One specimen obtained by Dr. Jordan at Galveston (Jordan & Gilbert, 1882).
229. **Tetrodon nephelus** (Goode & Bean). *Swellfish; Puffer*. Abundant at Galveston (as *Tetrodon turgidus nephelus*, Jordan & Gilbert, 1882). One specimen taken by us at Galveston and one at Corpus Christi.
230. **Chilomycterus schœpfii** (Walb.). Common about Galveston (Jordan & Gilbert, 1882).

CLASSIFIED LIST OF LOCALITIES MENTIONED.

In the following classified list of streams and localities an attempt has been made to arrange in order all the localities in Texas and the Rio Grande Basin from which any fish has ever been reported, as shown by the literature at our command. Some of the small creeks and springs mentioned in the earlier papers are quite difficult to locate definitely, but it is believed the classification here given is approximately, if not exactly, correct. It has been thought best to include, in a few cases, localities not in the actual limits of this paper, the object of which will be apparent upon an examination of the preceding detailed list of species. Isolated waters south of the Rio Grande, but which geographically belong in the Rio Grande Basin, have been included:

- Arkansas River:
    - Canadian River.
        - Spring Creek near Creswell.
        - Fulton Creek near Creswell.
        - Coal Creek.
        - Headwaters of Canadian River in the Llano Estacado.
        - Elm Creek.
        - Antelope Creek.
    - Poteau River near Fort Smith, Arkansas.
- Red River at Fulton, Arkansas.
    - Tributary of Red River at Fort Washita, Indian Territory.
    - Otter Creek, tributary of North Fork.
    - Gypsum Creek.
    - Sans Bois Creek.
    - Little Wichita River.
    - Turkey Creek.
- Sabine River at Longview.
- Neches River near Palestine.
- Trinity River at Fort Worth, Dallas, Magnolia Point, and at mouth.
    - Long Lake near Magnolia Point.
    - Elm Creek.
- San Jacinto River at Lynchburg.
- Buffalo Bayou near Houston.
    - Hunter Creek near Houston.
    - Big White Oak Bayou near Houston.
    - Sims Bayou near Houston.
    - Kilper's Pond near Houston.
- Dickinson Bayou at Nicholstone.
- Brazos River.
    - Clear Creek near Hempstead.
    - Leon River.
    - Lampasas River near Belton.
- Colorado River, headwaters of.
    - San Saba River at Fort McKavett.
    - Llano River in Kimble County.
    - Johnson Fork, in Kimble County.
    - Comanche Creek in Mason County.
- San Antonio River at San Antonio.
    - Guadalupe River at New Braunfels.
        - Comal Creek at New Braunfels.
        - Blanco River at San Marcos.
        - San Marcos River at San Marcos.
        - Dry Creek near Victoria.
    - Cibolo Creek.
        - Sutherland Springs.
    - Medina River at Helotes.
        - Tributary of Medina River.
        - Helotes Creek.
        - Wallace Creek in Bandera County, and the upper waters of Medina River.
    - Salado River.
    - San Antonio Springs, San Antonio.
    - San Pedro Creek, San Antonio.
- Nueces River.
    - Frio River.
        - Sabinal, Leona, and Seco rivers.
    - Upper tributaries of Nueces River.
    - Elm Creek.
    - Turkey Creek.
- Rio Grande at Alamesa, Loma, Sangre de Christo Pass, and (tributary) at Fort Garland in Colorado; San Ildefonso, at the mouth of the Hondo River, Albuquerque, Piedra Painte; (tributary) at Ojo de Gallo, (tributary) between Fort Defiance and Fort Union, (tributary) at Zoquito, and Fort Bliss in New Mexico; (tributaries) at Buena Vista, Acapulco, and Cuajuco, New Leon; Parras, and spring near Saltillo, Coahuila; (lagoon) at Palo Alto, Matamoras, and Boca Grande in Tamaulipas; Eagle Pass (lagoon), Fort Brown, and Brownsville in Texas.
    - San Felipe Creek.
        - San Felipe Springs.
    - Devil River.
    - Pecos River.
        - Live Oak Creek.
        - Headwaters of Pecos River.
        - Bonito River, New Mexico.
        - Delaware Creek.
        - Limpia River and Springs.
        - Comanche Springs.
        - Leon Springs.
        - Hurrah Creek.
    - Taos River, New Mexico.
    - Costilla Creek, New Mexico.
    - Rio Conejos at Alamosa, Colorado.
    - Chama River.
        - Tributary, at Abiquiu, New Mexico.
        - Brazos River, New Mexico.
- (?) Rio de Acama, New Mexico.
    - Utah Creek.
    - Lake Guzman.
        - Tributaries.
        - Rio Mimbres in Chihuahua.
        - Janos River.
        - Streams of the Sierra Madre.
    - Chihuahua River and tributaries.
    - Rio de las Conchas, Chihuahua.
    - Chihuahua near northern boundaries of Durango and Sinaloa.
    - Lago del Muerte, tributaries and springs near Monclova, Coahuila.
        - Nazas River at San Pedro.
    - Rio San Juan at China, and near Monterey, New Leon.
        - Rio San Diego near Cadereita, New Leon.

APPENDIX.

While carrying on the investigations for the purpose of selecting a site for a fish-cultural station in Texas in November and December, 1891, a considerable collection of mollusks and a small collection of reptiles and batrachians were made. The mollusks were collected almost wholly by Dr. R. R. Gurley, of the U. S. Fish Commission, and Mr. J. A. Singley, of the Texas geological survey, who accompanied our party during most of the time spent by us in the State. The large number of species found in the accompanying list attests their skill and enthusiasm as collectors. As many of these mollusks sustain an important relation to the fishes of the region in which they are found, the list may very properly be published here. No special search was made for reptiles and batrachians, but such as we chanced to see were collected and preserved. These were turned over to the National Museum, where they have been studied by Mr. F. C. Test, whose report is herewith presented.

ANNOTATED LIST OF THE REPTILES AND BATRACHIANS COLLECTED IN MISSOURI AND TEXAS IN THE FALL OF 1891.

[By Frederick C. Test, Aid, Reptile Department, U. S. National Museum.]

Texas is well known to abound in reptiles, but nearly all the species had gone into hibernation at the time of this expedition (November and December) and few were therefore seen. The list is of value, however, in that it shows what species of reptiles and batrachians of that region are to be seen so late in the fall. The four turtles collected are very interesting, and, taking everything into consideration, the entire collection, though small, is one of some importance.

1. **Malaclemmys kohnii** Baur. Four young turtles were captured, and are of especial note. They are different from any other species of this group, even differing in some of the markings on the head from this recently described species to which I have referred them. The slight differences, however, seem to me due to immaturity, and I therefore refer these four specimens to *M. kohnii*. The find extends the range of the species some little distance to the west of the type locality in southern Louisiana.

Museum No.	Collector's No.	Locality.	Date.
17692	11	Long Lake, near Trinity River, 12 miles southwest of Palestine, Tex.	Nov. 25
17693	12		
17694	13		
17695	14		

2. **Anolis principalis** L. One adult female of this so-called "chameleon," found in abundance in several Southern States, especially the adjoining one of Louisiana, was collected.

Museum No.	Collector's No.	Locality.	Date.
17696	4	Neches River, 14 miles east of Palestine, Tex....	Nov. 24

3. **Sceloporus undulatus** Dandin. This widely spread lizard is represented in the collection by one young individual.

Museum No.	Collector's No.	Locality.	Date.
17697	5	Neches River, 14 miles east of Palestine, Tex....	Nov. 24

4. **Carphophiops vermis** Kenn. One half-grown specimen of this retiring ground snake was obtained in southwestern Missouri. The salmon color of the under surface is particularly bright.

Museum No.	Collector's No.	Locality.	Date.
17698	2	U. S. Fish Commission Station, Neosho, Mo	Oct. 30

5. **Storeria dekayi** Holbrook. One specimen of this little snake, which seems to be quite commonly found at this time of year about water-courses, in the bottoms of ditches, and similar places, sometimes occurring dozens together, of all ages and sizes. In this individual the ground color is a shade lighter than usual, bringing out clearly the dark spots and markings, noticeably those about the head.

Museum No.	Collector's No.	Locality.	Date.
17699	3	New Braunfels, Tex................................	Dec. 2

6. **Spelerpes bilineatus** Green. One very small specimen was secured, still possessing gills and cirri. It is quite dark. This is the only salamander found.

Museum No.	Collector's No.	Locality.	Date.
17700	6	Neches River, 14 miles east of Palestine, Tex ...	Nov. 24

7. **Acris gryllus crepitans** Baird. Of this common little frog, or "peep," five specimens were collected. Nos. 17701, 17704, and 17705 are very typically and finely marked, but Nos. 17702 and 17703, in addition to the usual markings, have several small, circular, light spots on the back, giving them an odd, mottled appearance.

Museum No.	Collector's No.	Locality.	Date.
17701	7	Sims Bayou, 10 miles south of Houston, Tex....	Nov. 18
17702 17703	8 9	Big White Oak Bayou, 2 miles northwest of Houston, Tex.	Nov. 17
17704	10	New Braunfels, Tex................................	Dec. 3
17705	19	......do	Do.

8. **Rana pipiens pipiens** Schreber. One large specimen of typical proportions, but with unusually dark coloration. The ground color is quite dusky, and the posterior surfaces of the thighs are broadly mottled with black. The throat and front of femurs are flecked with brownish. This phase of coloring, though apparently not common, is paralleled by U. S. N. M. No. 3293, from Brownsville, Tex., collected by Capt. Van Vliet.

Museum No.	Collector's No.	Locality.	Date.
17706	18	New Braunfels, Tex	Dec. 3

9. **Rana catesbiana** Shaw. One medium-sized, quite dark specimen, with the under surface thoroughly marbled with dark brown, and nine tadpoles of this species were collected.

Museum No.	Collector's No.	Locality.	Date.
17707	15	Neches River, 14 miles east of Palestine, Tex.....	Nov. 24
17708-13	16	Trinity River, at Magnolia Point, 10 miles southwest of Palestine, Tex.	Nov. 23
17714-16	17	New Braunfels, Tex................................	Dec. 3

LIST OF MOLLUSCA COLLECTED IN TEXAS IN 1891.

[By J. A. Singley, Geological Survey of Texas.]

The collection of mollusca, of which a list is given below, was made by Dr. R. R. Gurley and the writer, while engaged in investigating the waters of Texas with the view of establishing a fish-cultural station in that State. No new species are described, but a new *Cytherea* (*C. texasiana*) has been described by Dr. W. H. Dall from material collected at Galveston during the investigation. The list also includes a number of marine species not heretofore recorded from the State, and gives new localities for several terrestrial and fluviatile species. The arrangement is that of Tryon's "Structural and Systematic Conchology."

1. **Spirula peronii** Lam. Galveston and Corpus Christi.
2. **Purpura hæmastoma** L. Galveston and Corpus Christi. It is abundant on the rocks at the Galveston jetty.
3. **Fasciolaria gigantea** Kien. Corpus Christi. Given on the authority of Dr. Gurley. I have not seen the species.
4. **Fulgur perversa** L. Corpus Christi and Galveston. Common at both places.
5. **Fulgur pyrum** Dillwyn. Galveston and Corpus Christi. Not common.
6. **Nassa vibex** Say. Galveston; beach-worn examples. Abundant, living at Corpus Christi, in Corpus Christi Bay and Laguna Madre. The Texas examples are dwarfed.
7. **Nassa acuta** Say. Common on Galveston Beach the latter part of November. A few beach-worn examples were found at Corpus Christi.
8. **Olivella mutica** Say. Beach-worn examples were found at Galveston.
9. **Oliva literata** Lam. A few broken shells found on Galveston Beach.
10. **Anachis obesa** C. B. Ad. Galveston and Corpus Christi; dead shells, not rare.
11. **Astyris lunata** Say. Dead and worn shells common on Galveston Beach, abundant living at Shamrock Cove, Corpus Christi Bay.
12. **Terebra concava** Say. Galveston Beach; not common; dead and worn shells only.
13. **Terebra dislocata** Say. Galveston Beach; commoner than the preceding and better preserved.
14. **Mangilia cerinella** Dall. Common at Galveston and Corpus Christi.
15. **Natica duplicata** Say. Galveston and Corpus Christi. An elevated and a depressed form are found. Common.
16. **Natica pusilla** Say. Galveston; beach-worn examples only. Not common.
17. **Sigaretus perspectivus** Say. Common on Galveston Beach.
18. **Crepidula fornicata** L. Abundant at Corpus Christi. A few found on Galveston Beach.
19. **Crepidula plana** Say. Galveston and Corpus Christi. Common.
20. **Crepidula convexa** Say. Corpus Christi. The species is given on the authority of Dr. Gurley.
21. **Solarium verrucosum** Phil. Galveston Beach, rare. Padre Island, Corpus Christi Bay, common.
22. **Scala contorquata** Dall. Galveston. Given on the authority of Dr. Gurley.
23. **Turbonilla interrupta** Totten. Galveston Beach. Not common.
24. **Litorina irrorata** Say. Abundant along the shore of Galveston Bay near Swan Lake.
25. **Modulus lenticularis** Chem. Corpus Christi. Given on the authority of Dr. Gurley.
26. **Cerithium variabile** C. B. Ad. Abundant in Shamrock Cove, Corpus Christi Bay.
27. **Bittium varium** Pfr. Galveston and Corpus Christi; abundant.
28. **Bittium cerithidioides** Dall. Galveston (Dr. Gurley).
29. **Seila terebralis** C. B. Ad. Dead shells found on the beach near Corpus Christi.
30. **Goniobasis pleuristriata** Say. Comal Creek, New Braunfels. The species is not common.
31. **Goniobasis comalensis** Pilsbry. Comal Springs and Guadalupe River, New Braunfels; San Marcos Springs and River, San Marcos. Abundant.
32. **Hydrobia texana** Pilsbry. Comal Creek, New Braunfels. Not common.
33. **Pyrgula spinosa** Call & Pilsbry. Comal Creek, New Braunfels. Rare.
34. **Amicola peracuta** Pilsbry & Walker. Comal Creek, New Braunfels; Long Lake, Anderson County. Abundant.
35. **Truncatella caribbaënsis** Sowb. Galveston.

36. **Truncatella pulchella** Pfr. Galveston. These two species of *Truncatella* are listed on the authority of Dr. Gurley. I have not found them in my Galveston material.
37. **Helicina orbiculata** Say. This species was found abundant at every point visited with the exception of Galveston Island.
38. **Fissurella alternata** Say. A few bleached and broken examples were found on the beach near Corpus Christi.
39. **Actæon punctostriatus** C. B. Ad. Galveston and Corpus Christi. Not common.
40. **Utriculus canaliculatus** Say. Galveston and Corpus Christi. Common.
41. **Bulla occidentalis** A. Ad. Corpus Christi. Dead shells abundant.
42. **Glandina decussata** Desh. var. **singleyana** W. G. Binney. One example found at New Braunfels.
43. **Zonites indentatus** Say. var. **umbilicata.** San Marcos, San Antonio, New Braunfels, and Palestine. Common.
44. **Zonites arboreus** Say. Found at same localities as the above, but much more abundant.
45. **Zonites fulvus** Drap. New Braunfels. Common.
46. **Zonites minusculus** Binn. New Braunfels. Common.
47. **Zonites singleyanus** Pilsbry. New Braunfels. Not common.
48. **Helix berlandieriana** Mor. Houston and Palestine. Common.
49. **Helix griseola** Pfr. Corpus Christi, San Antonio, and Austin. Abundant.
50. **Helix roemeri** Pfr. Austin. Abundant.
51. **Helix monodon** Rack. var. **fraterna** Say. New Braunfels. Common.
52. **Helix texasiana** Mor. Palestine, Austin, San Marcos, San Antonio, and Corpus Christi. Abundant.
53. **Helix mooreana** W. G. Binn. New Braunfels. Abundant.
54. **Helix hippocrepis** Pfr. New Braunfels. Rare.
55. **Helicodiscus lineatus** Say. New Braunfels. Not common.
56. **Bulimulus alternatus** Say. Corpus Christi. Typical *alternatus* was found west of Corpus Christi, while a variety intermediate between *alternatus* and *schiedeanus* was found along the bluffs bordering on Corpus Christi Bay.
57. **Bulimulus dealbatus** Say. Palestine. Two examples.
58. **Bulimulus schiedeanus** Pfr. New Braunfels and San Antonio. Common.
59. **Bulimulus schiedeanus mooreanus** W. G. Binn. San Antonio, New Braunfels, San Marcos, and Austin. Abundant. These so-called "species" of *Bulimulus* are simply variations of one species. At each of the given localities examples were found that connected two or more forms and could not be satisfactorily referred to any one "species."
60. **Holospira roemeri** Pfr. New Braunfels. Very rare.
61. **Holospira goldfussi** Menke. New Braunfels. Common.
62. **Macroceramus gossei** Pfr. New Braunfels. Common.
63. **Pupa fallax** Say. New Braunfels. Abundant.
64. **Pupa procera** Gould. New Braunfels. Common.
65. **Pupa contracta** Say. Palestine, New Braunfels. Common.
66. **Pupa pentodon** Say. New Braunfels. Common.
67. **Pupa curvidens** Gould. New Braunfels. Not common.
68. **Pupa armifera** Say. New Braunfels. Two examples.
69. **Succinea grosvenori** Lea. Palestine. Rare.
70. **Physa forsheyi** Lea. Long Lake, Anderson County. Not common.
71. **Physa halei** Lea. San Antonio Springs and San Marcos springs and river; also in Comal Creek, New Braunfels. Abundant.
72. **Limnæa humilis** Say. Long Lake, Anderson County. Not common.
73. **Limnæa desidiosa** Say. San Antonio Springs, San Antonio; San Marcos Springs and River, San Marcos. Not common.
74. **Planorbis liebmanni** Dunker. Comal Creek, New Braunfels. Common.
75. **Planorbis lentus** Say. Long Lake, Anderson County; Comal Creek, New Braunfels. Common.
76. **Planorbis bicarinatus** Say. San Marcos River, San Marcos. Not common.
77. **Ancylus excentricus** Morelet. Comal Creek, New Braunfels. Very rare.
78. **Pholas truncata** Say. Corpus Christi. Not common.
79. **Pholas costata** L. Single valves abundant at Galveston and Corpus Christi.
80. **Solen directus** Conrad. Corpus Christi. Young shells abundant. No adults were found.
81. **Tagelus gibbus** Spengler. Galveston and Corpus Christi. Common.
82. **Mactra lateralis** Say. Corpus Christi and Galveston. Abundant.

83. **Mactra brasiliana** Lam. Corpus Christi (Dr. Gurley).
84. **Gnathodon cuneata** Con. Corpus Christi and Galveston. Abundant. The Givens Oyster Company, at Corpus Christi, were canning this species and putting it on the market labeled "Little Neck Clams."
85. **Gnathodon rostrata** Petit. Galveston (Dr. Gurley).
86. **Labiosa canaliculata** Say. Single valves are abundant at Corpus Christi and Galveston.
87. **Semele reticulata** Gmel. Galveston (Dr. Gurley).
88. **Abra æqualis** Say. Galveston. Not common.
89. **Cumingia tellinoides** Con. Corpus Christi. Not common.
90. **Tellina alternata** Say. Galveston and Corpus Christi. Abundant.
91. **Tellina polita** Say. Corpus Christi (Dr. Gurley).
92. **Macoma constricta** Brug. Galveston and Corpus Christi. Not common.
93. **Macoma brevifrons** Say. Galveston (Dr. Gurley).
94. **Donax tumida** Retz. Galveston and Corpus Christi. Abundant.
95. **Donax roemeri** Pfr. Galveston and Corpus Christi. Not common.
96. **Petricola pholadiformis** Lam. Single valves were found at Galveston and Corpus Christi.
97. **Venus cancellata** L. Dead shells are very abundant on the beach at Corpus Christi. A few beach-worn shells found at Galveston.
98. **Venus mercenaria** L. Corpus Christi (Dr. Gurley).
99. **Venus mercenaria** L. var. **mortoni** Con. Galveston and Corpus Christi. Common.
100. **Venus rostrata** Sowb. Corpus Christi. Common.
101. **Cytherea texasiana** Dall. Galveston. Single valves are not uncommon on Galveston beach.
102. **Cytherea gigantea** Gmel. Galveston and Corpus Christi. Common.
103. **Dosinia discus** Reeve. Galveston and Corpus Christi. Common.
104. **Pisidium compressum** Prime. Comal Creek, New Braunfels. Common.
105. **Sphærium singleyi** Pilsbry. White Oak Bayou, Houston; Guadalupe River, New Braunfels. Not common.
106. **Cardium muricatum** L. Galveston and Corpus Christi. Single valves are common.
107. **Cardium magnum** Born. Galveston and Corpus Christi. Abundant.
108. **Lævicardium mortoni** Con. Abundant, living in Corpus Christi Bay. Single valves only found at Galveston.
109. **Lucina crenulata** Con. Single valves abundant in the beach drift at Corpus Christi.
110. **Unio undulatus** Barnes. San Antonio River at the waterworks station, San Antonio. Two odd valves only were found.
111. **Unio asper** Lea. Long Lake, Anderson County. Abundant.
112. **Unio texasensis** Lea. Long Lake, Anderson County. Common.
113. **Anodonta stewartiana** Lea. Long Lake, Anderson County. A number of fine examples of this species were taken.
114. **Leda concentrica** Say. Single valves common at Galveston and Corpus Christi.
115. **Arca ponderosa** Say. Beach-worn valves are common at Galveston and Corpus Christi.
116. **Arca transversa** Say. Single valves common at Galveston and Corpus Christi.
117. **Arca incongrua** Say. Galveston and Corpus Christi. Abundant.
118. **Arca pexata** Say. A few valves found at Galveston.
119. **Arca americana** Gray. Corpus Christi (Dr. Gurley).
120. **Mytilus cubitus** Say. Corpus Christi. Common on oysters.
121. **Mytilus hamatus** Say. Galveston and Corpus Christi. Very abundant on oyster reefs.
122. **Modiola plicatula semicostata** Conrad. A fine large example was taken in Galveston Bay (near the bayou connecting Swan Lake with the bay) while seining in shallow water there.
123. **Pinna muricata** L. A few valves found at Corpus Christi.
124. **Plicatula ramosa** Lam. Galveston (Dr. Gurley).
125. **Pecten irradians** Lam. Beach-worn valves are common at Galveston and Corpus Christi.
126. **Pecten irradians dislocatus** Say. Same distribution and abundance as *P. irradians*. I found it living in Corpus Christi Bay.
127. **Anomia simplex** Orbigny. Single valves are washed up on the beach at Galveston. A number were found living at Corpus Christi.
128. **Ostrea virginica** Gmel. The most common mollusk on the Texas coast. For a discussion of the commercial phase of the oyster industry on the Texas coast, see Mr. C. H. Stevenson's paper in the report of the U. S. Commissioner of Fish and Fisheries for 1889–91.

EXPLANATION OF PLATES.

The 50 plates which follow give illustrations of 107 of the 230 species of fishes now known to occur in the waters of Texas and the Rio Grande basin. The species are arranged substantially in the order in which they come in the text. Under each illustration are given: (1) the scientific name; (2) the common name, the more generally accepted in italics, those of local use in roman; (3) the locality, when known, from which the specimen drawn was obtained; (4) the name of the artist who made the original drawing. Many of these drawings were made several years ago by Mr. H. L. Todd. A few others were made by Mr. William Haines, Miss M. Smith, and Mr. S. F. Denton. The remaining 17 species were drawn by Mr. A. H. Baldwin especially for this paper.

Plate No.	
X.	*Pristis pectinatus*. Sawfish.
	Scaphirhynchus platyrhynchus. Shovel-nosed Sturgeon.
	Lepisosteus platystomus. Short-nosed Gar.
XI.	*Noturus nocturnus*.
	Leptops olivaris. Yellow Cat; Mud Cat.
	Ameiurus melas. Bullhead.
XII.	*Ameiurus nebulosus catulus*.
	Ameiurus natalis. Yellow Cat.
	Ameiurus lupus.
XIII.	*Ictalurus furcatus*. (From type of *Pimelodus affinis* Grd.) Chuckle-head Cat; Blue Cat.
	Ictalurus punctatus. Channel Cat; Eel Cat.
	Tachysurus felis. Sea Catfish.
XIV.	*Felichthys marinus*. Gaff-topsail.
	Ictiobus cyprinella. Common Buffalo-fish.
	Carpiodes carpio. Carp Sucker.
XV.	*Catostomus teres*. Common White Sucker.
	Erimyzon sucetta. Chub Sucker; Creek Sucker.
	Minytrema melanops. Striped Sucker.
XVI.	*Moxostoma congestum*.
	Campostoma anomalum. Stone-roller.
	Notropis cayuga atrocaudalis. Type.
XVII.	*Notropis nux*. Type.
	Notropis nocomis. Type.
	Notropis swaini.
XVIII.	*Notropis fumeus*. Type.
	Notropis notemigonoides. Type.
	Rhinichthys dulcis. Dace.
XIX.	*Hybopsis æstivalis marconis*.
	Semotilus atromaculatus. Horned Dace.
	Opsopœodus oscula. Type.
XX.	*Notemigonus chrysoleucus*. Bream.
	Megalops atlanticus. Tarpon.
	Clupea chrysochloris. Skipjack.
XXI.	*Brevoortia tyrannus patronus*. Gulf Menhaden.
	Dorosoma cepedianum. Gizzard Shad.
	Synodus fœtens. Lizard-fish.
XXII.	*Salmo mykiss spilurus*. Rio Grande Trout.
	Cyprinodon variegatus. Variegated Minnows.
XXIII.	*Fundulus pallidus*. Type.
	Fundulus zebrinus.
	Fundulus diaphanus, Spring Minnow.
XXIV.	*Zygonectes funduloides*. Type.
	Zygonectes pulvereus. Type.
	Zygonectes jenkinsi. Type.
	Zygonectes notatus. Top Minnow.
XXV.	*Lucania parva*.
	Gambusia affinis.
	Lucius vermiculatus. Little Pickerel.
XXVI.	*Gymnothorax ocellatus nigromarginatus*. Type.
	Anguilla chrysypa. Common Eel.
XXVII.	*Hemirhamphus unifasciatus*. Half-beak.
	Mugil cephalus. Common Mullet.
	Polynemus octonemus Threadfin.
XXVIII.	*Vomer setipinnis*. Moonfish.
	Selene vomer. Silver Moonfish.
XXIX.	*Caranx hippos*. Horse Crevallé.
	Chloroscombrus chrysurus. Bumper.
XXX.	*Trachynotus carolinus*. Pompano.
	Aphredoderus sayanus. Pirate Perch.
XXXI.	*Pomoxis annularis*. Crappie.
	Pomoxis sparoides. Calico Bass.
XXXII.	*Chænobryttus gulosus*. Warmouth.
	Lepomis symmetricus.
XXXIII.	*Lepomis megalotis*, Large-eared Sunfish.
	Lepomis pallidus. Blue Sunfish; Blue-gill.
XXXIV.	*Micropterus salmoides*. Large-mouthed Black Bass.
	Etheostoma pellucidum clarum. Sand Darter.
	Etheostoma chlorosoma.
XXXV.	*Etheostoma micropterus*.
	Etheostoma caprodes. Log Perch.
	Etheostoma lepidogenys. Type.
XXXVI.	*Etheostoma shumardi*.
	Etheostoma jessiæ.
	Etheostoma fusiforme.
	Etheostoma fonticola.
XXXVII.	*Centropomus undecimalis*. Robalo.
	Morone interrupta. Yellow Bass.
	Roccus chrysops. White Bass.
XXXVIII.	*Lutjanus caxis*. Gray Snapper.
	Lutjanus aya. Red Snapper.
XXXIX.	*Rhomboplites aurorubens*. Mangrove Snapper.
	Orthopristis chrysopterus. Hogfish.
XL.	*Archosargus probatocephalus*. Sheepshead.
XLI.	*Lagodon rhomboides*. Pinfish.
	Aplodinotus grunniens. Fresh-water Drum.
XLII.	*Pogonias chromis*. Drum.
	Bairdiella chrysura. Yellow-tail.
XLIII.	*Sciæna ocellata*. Red Drum; Redfish.
	Micropogon undulatus. Croaker.
	Menticirrihus americanus. Whiting.
XLIV.	*Leiostomus xanthurus*. Spot.
	Cynoscion nothus.
	Cynoscion nebulosus. Spotted Sea Trout.
XLV.	*Chætodypterus faber*. Angel-fish.
	Gobionellus oceanicus. Emerald-fish.
XLVI.	*Prionotus scitulus*. Sea Robin.
	Upsilonphorus y-græcum. Star-gazer.
	Astroscopus anoplos. Electric Dogfish.
XLVII.	*Isesthes ionthas*. Blenny.
	Ophidion marginatum.
	Etropus crossotus.
XLVIII.	*Paralichthys lethostigma*. Southern Flounder
	Ancylopsetta quadrocellata.
XLIX.	*Ostracion tricorne*. Cowfish.
	Alutera schœpfi. Orange Filefish.
	Lagocephalus lævigatus. Smooth Puffer.
L.	*Tetrodon nephelus*. Swellfish; Puffer.
	Chilomycterus schœpfi. Swelltoad; Burrfish.

151. Lepomis albulus (Girard). Rio Blanco (as *Bryttus albulus* types, Girard, 1857, and Girard, 1858, pl. VI, figs. 1–4). The type (U. S. N. M. No. 421) is 7 inches long and in excellent condition. Head, 2¾; depth, 2⅜; eye, 4⅓; snout, 3⅓; scales, 7–42–12, 5 rows on cheek.

152. Micropterus salmoides (Lac.). *Big-mouthed Black Bass; "Trout."* Rio Frio and Rio Nueces (as *Grystes nuecensis* types, Baird & Girard, 1854). Rio Blanco, Rio Frio, Rio Leon, Rio Seco, Rio Medina, Rio Brazos, Rio Nueces, Rio Leona, Rio Sabinal, Minneville River, Delaware Creek, Live Oak Creek, Dry Creek, Turkey Creek, Elm Creek, and San Pedro Creek; San Juan River, New Leon (as *Dioplites nuecensis*, Girard, 1858). Rio Frio, Rio Nueces, Live Oak Creek, Turkey Creek, Rio Leona, Elm Creek, Rio Sabinal, Dry Creek, San Pedro Creek, Minneville River, and San Juan River, New Leon (as *Dioplites nuecensis*, Girard, 1859, pl. I). Trinity, Llano, Guadalupe, and Medina rivers, and Johnson Fork of Llano River in Kimble County (as *Micropterus floridanus*, Cope, 1880). Red River at Fulton, Ark., Sabine River at Longview, Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Neches River east of Palestine, Trinity River and Long Lake at Magnolia Point, San Jacinto River at Lynchburg, Dickinson Bayou near Dickinson, Buffalo Bayou, Hunter Creek, Big White Oak Bayou near Houston, San Marcos River at San Marcos, and San Antonio River at San Antonio. The big-mouthed black bass is, as the above list of localities shows, an abundant and widely distributed fish in Texan waters. It is not confined to the fresh-water streams, but is also found in brackish-water bayous. In Dickinson Bayou we found it associated with such salt or brackish water forms as oysters, shrimps, flounders, and *Sciæna ocellata*. With these were also found *Lepomis pallidus*, *Ictiobus cyprinella*, *Notemigonus chrysoleucus*, *Lepisosteus platystomus*, and *Gerres gracilis*.

XXXII.—PERCIDÆ. THE DARTERS.

153. Etheostoma pellucidum clarum (Jordan & Meek). *Sand Darter.* Red River at Fulton, Ark., and Sabine River at Longview (as *Ammocrypta clara*, Jordan & Gilbert, 1886).

154. Etheostoma vivax (Hay). Sabine River at Longview (as *Ammocrypta vivax*, Jordan & Gilbert, 1886).

155. Etheostoma phlox (Cope). Trinity River near Fort Worth (as *Boleosoma phlox* types, Cope, 1880). Trinity River (as *Ulocentra phlox*, Synopsis).

156. Etheostoma chlorosoma (Hay). Three specimens of this little darter were taken in a pond on the bank of the Neches River east of Palestine, and one each in Kilper's Pond and Buffalo Bayou at Houston.

157. Etheostoma shumardi (Grd.). Red River, Fulton, Ark. (as *Cottogaster shumardi*, Jordan & Gilbert, 1886).

158. Etheostoma caprodes (Raf.). *Log Perch.* Rio Salado (as *Pileoma carbonaria* types, Baird & Girard, 1853). Rio Salado, Rio Medina, and San Pedro Creek (as *Pileoma carbonaria*, Girard, 1859, pl. VIII, figs. 10–13). Trinity River near Dallas and Llano River, Kimble County (as *Percina caprodes carbonaria*, Cope, 1880). Rio Colorado at Austin (as *Percina caprodes*, Jordan & Gilbert, 1886). Three specimens from Long Lake near Magnolia Point and one from the Neches River east of Palestine. The Long Lake specimens are quite thickly covered with larval trematodes occurring as small black specks scattered over the body with no apparent regularity, or, in other words, no one portion of the fish seems much more vulnerable than another to the attacks of this parasite. This darter is a species which frequents clear running water or clear lakes and its occurrence in such stagnant bodies of water as that of Long Lake is unusual; its being attacked by trematodes well illustrates one of the dangers which result from the transfer of any fish from clear, cool, running water to water which is more or less stagnant and impure. Active species transferred to such a pond or bayou are almost certain to suffer from the attacks of trematodes and other parasites, while those fishes which live habitually in such waters are less liable to be affected.

159. Etheostoma fasciatus (Grd.). Chihuahua River (as *Diplesion fasciatus* types, Girard, 1859*b*).

160. Etheostoma sciereum serrula (J. & G.). Sabine River at Longview (as *Hadropterus scierus serrula* var. nov. types, Jordan & Gilbert, 1886). Trinity River at Dallas, Rio Lampasas at Belton, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (as *Hadropterus scierus serrula*, Jordan & Gilbert, 1886). The recent collection contains 42 specimens from

San Marcos River at San Marcos, 76 from Guadalupe River near New Braunfels, 2 from Big White Oak Bayou, 17 from Buffalo Bayou, 5 from Hunter Creek at Houston, 12 from Trinity River, and 3 from Neches River near Palestine.

161. **Etheostoma lepidum** (B. & G.). Upper tributaries of the Rio Nueces (as *Boleosoma lepida* types, Baird & Girard, 1853). Rio Leona (as *Pœcilichthys lepidus*, Girard, 1859, pl. VIII, figs. 14–17). Brownsville (as *Pœcilichthys lepidus*, Jordan, 1878). Rio Lampasas at Belton, Rio Colorado at Austin, Rio San Marcos at San Marcos, and Rio Comal at New Braunfels (Jordan & Gilbert, 1886). Our own collection contains 13 specimens of this darter from San Marcos River at San Marcos and 9 from Comal Creek at New Braunfels. In all of these the cheeks and opercles are entirely naked. Examination shows considerable variation in the development of the lateral line and in the number of scales on the two sides of the body. The number of scales in a longitudinal series varies from 48 to 54, and the difference between the two sides is usually 2 or 3 scales. The following tabular statement shows the variation in the 9 specimens from New Braunfels. In this table the series composing the lateral line itself is included with those designated "above the lateral line."

Series above lateral line.		Series below lateral line.		Scales in longitudinal series.			
				Right side.		Left side.	
Right side.	Left side.	Right side.	Left side.	With pores.	Without pores.	With pores.	Without pores.
7	7	9	9	36	15	35	15
7	7	9	7	32	21	31	19
7	7	7	8	34	17	35	17
7	7	8	7	32	19	32	19
7	7	8	8	20	28	27	23
7	7	8	9	32	19	35	19
7	7	8	8	32	19	33	19
6	6	7	7	34	17	34	18
7	7	8	8	32	18	31	17

162. **Etheostoma lepidogenys** sp. nov. Allied to *Etheostoma lepidum*. Head (including opercular flap), 4; depth, 5; eye, 4; snout, 4; dorsal, X–12; anal, II–7 or 8. Scales, 7–54 to 61–9, lateral line straight and incomplete, 32 to 38 pores. Body moderately stout, head heavy, snout short, blunt and decurved, back little elevated, caudal peduncle deep, its least depth 2 in head. Mouth rather small, but little oblique, lower jaw slightly included, premaxillary just reaching front of orbit, not protractile (*i. e.*, frenum present). Gill-membranes scarcely united. Fins moderate, soft dorsal higher than spinous portion, pectoral short, only as long as head, not reaching beyond tips of ventrals; ventrals short, distance from their tips to origin of anal equals half length of head; anal rather small, scarcely reaching tips of soft dorsal when depressed. Scales strongly ctenoid, cheeks densely scaled, opercles and breast entirely naked, nape scaled; median line of belly with ordinary scales, not deciduous. In the larger specimen, which is 2 inches long, there are on the right side 57 scales in a longitudinal series, upon 38 of which pores are developed, while upon the left side there are but 54 scales, upon 35 of which pores are developed. The second specimen, 1¾ inches long, has 61 scales upon the right side with pores in 38 of them, and 55 upon the left with only 35 developed pores. This shows a considerable variation, not only among individuals, but between the two sides of the same individual. Color in alcohol: Head dark above, sides pale, a dark line forward from eye to tip of snout and another broader one straight downward from the eye, broadest at lower end; a dark postocular spot followed by a fainter one on the opercle; dark humeral scale present; side of body with about 13 dark vertical bars, the first crossing over the back just in front of the spinous dorsal, the next four indistinct except on back where they widen into large blotches, the sixth crossing the back between the two dorsals; the seventh to tenth, inclusive, are under the soft dorsal; the eleventh crosses just back of it, while the thirteenth is at the base of the caudal fin; spinous dorsal pale at base, next a broad dark band, then a narrow pale one which is followed by a pale blue one, probably blue in life, and lastly the fin is tipped with a very narrow margin of white; soft dorsal marbled or vermiculated with brown, the largest,

plainest markings being at about one-third the distance from the tips of the fin; caudal like the soft dorsal, but the colors deeper; all the other fins unmarked.

From *Etheostoma lepidum*, which this species most resembles and which we at first supposed it to be, it differs chiefly in the squamation of the cheeks. In that species the cheeks, as well as the opercles, are scaleless, while in this the cheeks are densely scaled. It also differs from *E. lepidum* in having smaller mouth, shorter, blunter, more decurved snout, and in the slightly smaller scales. In *lepidum* the number of scales in a longitudinal series, in 9 specimens from Comal Creek, varies from 48 to 54, while in this species the variation is from 54 to 61. This species resembles *Etheostoma cœruleum* also, but in that species the opercles are more or less scaled and the cheeks naked or very nearly so; the scales are also larger in *cœruleum* and the color is different. The types of this species consist of two specimens, 1¾ and 2 inches long, respectively, obtained in Comal Creek at its beginning in the largest of the Comal Springs, at New Braunfels, Tex., December 3, 1891. (U. S. N. M. No. 44840).

163. **Etheostoma micropterus** Gilbert. "A single specimen 1¾ inches long; collected by Mr. E. Wilkinson, at Chihuahua, Mexico. U. S. N. M. No. 38245." (Type, Gilbert, 1890.)

164. **Etheostoma australe** Jordan. Chihuahua River (as *Diplesion fasciatus* types, perhaps only in part, Girard, 1859*b*, and as *Etheostoma australe* types, Jordan, 1888). Rio de las Conchas, Chihuahua (as *Etheostoma scovelli* types, Woolman, 1892). The types of *E. australe* were found among the original types of *D. fasciatus* (No. 24625, M. C. Z.).

165. **Etheostoma jessiæ** (Jordan & Brayton). Sabine River at Longview (Jordan & Gilbert, 1886).

166. **Etheostoma fusiforme** (Grd.). Rio Seco and Rio Leona at Uvalde (as *Boleosoma gracile* types, Girard, 1859*b*), and (as *Pœcilichthys gracilis*, Synopsis). Trinity River at Dallas (Jordan & Gilbert, 1886). We have 3 specimens from Buffalo Bayou at Houston, 42 from Sims Bayou near Houston, 12 from Hunter Creek near Houston, and 1 from Neches River east of Palestine. The cheeks and opercles on all of these specimens are densely scaled, and the lateral line is developed on 20 to 22 scales.

167. **Etheostoma lateralis** (Grd.). Mouth of the Rio Grande del Norte (as *Alvarius lateralis* types of genus and species, Girard, 1859*b*). Rio Grande (as *Pœcilichthys lateralis*, Synopsis).

168. **Etheostoma fonticola** J. & G. Rio San Marcos (as *Alvarius fonticola* types, Jordan & Gilbert, 1886). This interesting little darter was found in abundance in Comal River at New Braunfels and the collection contains 43 specimens taken there. One specimen was found in Dickinson Bayou very close to brackish water. This is one of the smallest of darters, the largest specimens scarcely exceeding 1½ inches in total length.

XXXIII.—SERRANIDÆ. THE SEA BASS.

169. **Centropomus undecimalis** (Bloch). *Robalo.* Galveston (Jordan & Gilbert, 1882). A few fish of this species were examined in the market at Corpus Christi, but we saw none at Galveston.

170. **Roccus chrysops** (Raf.). *White Bass.* Red River at Fulton, Ark. (Jordan & Gilbert, 1886).

171. **Morone interrupta** Gill. *Yellow Bass.* Common in the lower portions of the San Jacinto and Trinity rivers, from which it is brought in considerable numbers to the Houston market.

XXXIV.—SPARIDÆ. THE SPAROID FISHES.

172. **Lutjanus caxis** (Bloch & Schneider). *Gray Snapper.* Brazos Santiago and mouth of Rio Grande (as *Neomœnsis emarginatus*, Girard, 1859, pl. IX, figs. 5–8).

173. **Lutjanus aya** (Bloch). *Red Snapper.* This important food-fish is brought to the Galveston market from banks not far distant.

174. **Rhomboplites aurorubens** (C. & V.). Brazos Santiago (as *Conodon antillanus*, Girard, 1859).

175. **Orthopristis chrysopterus** (L.). *Pigfish; Sailor's Choice.* Indianola and Brazos Santiago (as *Orthopristis duplex* types, Girard, 1859, pl. IX, figs. 1–4). Galveston (as *Pomadasys fulvomaculatus*, Jordan & Gilbert, 1882). Three specimens of this were gotten at Corpus Christi, where it is of some value as a food-fish. An example 9 inches long gives the following measurements: Head, 3½; depth, 2½; eye, 5½; D. XII–15; A. III–13; scales, about 55 in length of

lateral line. A young specimen, 4⅛ inches long, has the head, 3; depth, 2¾; D. XIII-13; A. III-12; scales, about 55 with pores; eye large, 3¼ in head, and greater than the interorbital width.

176. Lagodon rhomboides (L.). *Pinfish; Chopa Spina.* Brazos, Indianola, St. Joseph Island, and Brazos Santiago (Girard, 1859, pl. IX, figs. 13-16). Galveston (Jordan & Gilbert, 1882). Galveston and Corpus Christi, at both of which places it is an abundant species.

177. Archosargus probatocephalus (Walb.). *Sheepshead.* Indianola and Brazos Santiago (as *Sargus ovis*, Girard, 1859). Galveston and Corpus Christi.

XXXV.—SCIÆNIDÆ. THE CROAKERS.

178. Aplodinotus grunniens Raf. *Fresh-water Drum.* Mouth of Rio Grande and Matamoras (as *Amblodon neglectus* types, Girard, 1859, pl. V, figs. 6-10). Red River at Fulton, Ark., and Rio Colorado at Austin (Jordan & Gilbert, 1886). Numerous specimens seen in the Houston market, from the mouth of the Trinity River.

179. Pogonias chromis (L.). *Salt-water Drum.* Galveston (Jordan & Gilbert, 1882). Found by us at Galveston, but not seen at Corpus Christi. Brazos Santiago (as *Pogonias fasciatus*, Girard, 1859).

180. Stelliferus lanceolatus (Holbrook). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859).

181. Bairdiella chrysura (Lac.). *Yellow-tail.* Galveston (as *Sciæna punctata*, Jordan & Gilbert, 1882). A dozen specimens were obtained by us at Corpus Christi, where it is an abundant fish.

182. Sciæna ocellata (L.). *Redfish; Channel Bass.* Indianola (as *Johnius ocellatus*, Girard, 1859, pl. VIII, figs. 1-4). Galveston (Jordan & Gilbert, 1882). An abundant and important food-fish at Galveston and Corpus Christi. Specimens 38 and 39 inches in length at Galveston weighed 46 pounds each. In the Houston market this fish was selling at 10 cents a pound. Dickinson Bayou.

183. Leiostomus xanthurus Lac. *Spot; Goody.* Brazos Santiago and Indianola (as *Leiostomus obliquus*, Girard, 1859). St. Joseph Island (as *Homoprion lanceolatus*, Girard, 1859). Brazos Santiago and St. Joseph Island (as *Homoprion xanthurus*, Girard, 1859). Galveston (Jordan & Gilbert, 1882). Found by us both at Galveston and Corpus Christi.

184. Larimus fasciatus (Holbrook). Eleven small examples, 2 to 4¼ inches long, were obtained at Galveston.

185. Micropogon undulatus (L.). *Croaker.* Mouth of the Rio Grande, Indianola, St. Joseph Island, and Galveston (Girard, 1859, pl. VII). Galveston (Jordan & Gilbert, 1882). Taken by us only at Galveston.

186. Menticirrhus littoralis (Holbrook). *Surf Whiting.* Galveston (Jordan & Gilbert, 1882). A single small specimen gotten by us at Galveston.

187. Menticirrhus americanus (L.). *Whiting.* Indianola and Brazos Santiago (as *Umbrina phalæna* types, Girard, 1859, pl. V, figs. 1-5). Galveston (as *Menticirrus alburnus*, Jordan & Gilbert, 1882). One specimen in the collection from Galveston. Each of these two species is common, however, at Galveston, and will doubtless be found all along the Texas coast.

188. Cynoscion nothus (Holbrook). Brazos Santiago (as *Otolithus nothus*, Girard, 1859).

189. Cynoscion nebulosus (C. & V.). *Spotted Sea Trout.* Brazos Santiago, Brazos, and Indianola (as *Otolithus drummondi*, Girard, 1859, pl. VI). Galveston (Jordan & Gilbert, 1882). Corpus Christi and Galveston. Also seen in the Houston market from the mouth of Trinity River.

XXXVI.—GERRIDÆ. THE GERROIDS.

190. Gerres gula (C. & V.). Brazos Santiago, Brazos, Indianola, and St. Joseph Island (as *Eucinostomus argenteus*, Girard, 1859, pl. IX, figs. 9-12). Taken by us only at Corpus Christi.

191. Gerres gracilis (Gill). There are in the present collection fourteen specimens representing Corpus Christi, Galveston, Dickinson Bayou, and Buffalo Bayou at Houston. This last locality is 60 miles from salt water.

XXXVI.—CICHLIDÆ. THE CICHLIDS.

192. Heros cyanoguttatus B. & G. Fresh water at Brownsville (as *Heros* [illegible], types, Baird & Girard, 1854). Lagoon at Fort Brown, Brownsville, Matamoros, San Juan [illegible], and Monterey, New Leon, and Devil River (as *Heros* [illegible], Girard, 1859, pl. [illegible]). The type of this species [illegible] is about [illegible] in [illegible] length and is in excellent condition. It is well described in Jordan & Gilbert's Synopsis.

193. Heros pavonaceus Garman. Monclova, Coahuila (types, Garman, 1881, and [illegible]). This and the preceding species are the most northern representatives of the Cichlidæ, a family represented in Central and South America by many species.

XXXVII.—BLENNIIDÆ. THE [illegible]

194. Chasmodes [illegible] [illegible]. [illegible] Galveston (Jordan & Gilbert, 1882). Two small specimens obtained by us at Galveston.

XXXVIII.—GOBIIDÆ. THE GOBIES.

195. Philypnus dormitor [illegible]. Near mouth of the Rio Grande (as *Philypnus* [illegible], Girard, 1859, pl. XI, fig. [illegible]).

196. Dormitator maculatus (Bloch). Near mouth of the Rio Grande (as *Eleotris* [illegible], Girard, 1859, pl. XI, figs. [illegible] and [illegible], and *Eleotris somnolentus*, types, Girard, 1859, pl. XI, figs. [illegible]). We obtained two small specimens at Galveston in Galveston Bay.

197. Gobius [illegible] Girard. Brazos Santiago (types, Girard, 1858 and 1859, pl. XII, figs. [illegible]). Galveston (Jordan & Gilbert, 1882). Rio Grande (as *Lepidogobius* [illegible], Steindachner). Taken by us at Galveston.

198. Gobius soporator C. & V. [illegible]. St. Joseph Island (as *Gobius* [illegible], types, Girard, 1859, pl. XII, figs. 9 and 10). St. Joseph Island (as *Gobius* [illegible], Steindachner).

199. Gobius boleosoma J. & G. [illegible]. Several specimens obtained by us at Galveston, [illegible], and at [illegible], from which the following description is taken: Head [illegible]; depth [illegible]. D. [illegible]; A. [illegible]. Scales [illegible]. Body somewhat compressed. Head moderate; snout evenly decurved, equal to eye. Eye [illegible] in head, its diameter about equal to the interorbital space. Mouth moderate, maxillary extending slightly beyond front of orbit. Teeth slender, in several rows. Scales moderate, ctenoid, those in front somewhat reduced. Ventral fins [illegible] pointed, nearly as long as head; pectoral shorter than caudal, ventral shorter than caudal. Region before dorsal and breast naked, belly scaly. Color light olivaceous, finely mottled with darker; along the middle of side are four or five oblong dark blotches, the last being at base of caudal; a [illegible] spot above gill-opening; top of head finely marked above with darker; a dark bar extending from near angle of mouth nearly to edge of preopercle; also a dark bar from maxillary to lower front of eye; dorsals dusky with silvery edge; [illegible] barred with darker; ventral pale, with two dark lines through the middle; in some [illegible] with pale margin; head and [illegible] punctulate with darker. Other specimens with no distinct spots or dark punctulations on breast, and ventrals with no dark markings. Spots on the sides of all the specimens range from linear to nearly round. In their review of the *Gobiidæ*, Jordan & Eigenmann, Proc. U. S. Nat. Mus. 1886, 495, state that the breast, nape, and belly of this species are naked, but in our specimens, as well as in some other specimens identified by Dr. Jordan, and with which our specimens were compared, the belly is always evidently scaly, as also the belly of *G. stigmaticus*, which was said to be naked. The thinness and transparency of the scales on the belly cause it to appear naked in some specimens.

The following table gives measurements of 14 specimens:

Head.	Depth.	Eye.	Dorsal.	Anal.	Scales.
4¼	5⅕	4	VI-11 or 12	11	30
4	5⅓	4	VI-11	11	30 or 31
4	4¾	3⅘	VI-12 or 13	13 or 14	30 or 31
4	5⅗	4	VI-11 or 12	12	30 or 31
4⅗	5⅕	4	VI-11 or 12	11 or 12	30 or 31
4⅗	5⅓	3½	VI-11 or 12	13 or 14	....
4⅓	5	4	VI-11	11	30 or 31
4⅗	4⅔	4, nearly.	VI-11	11	29 or 30
4⅗	5⅓	3⅘	VI-11	12	30, about.
4+	5⅓	4	VI-11	11	28 or 29
4	5⅓	4+	VI-11	11	28 or 29
4	5+	4	VI-11	12	26, about.
4+	5⅔	3½	VI-11	11	28
4	5⅔	3+	VI-?	11	29 or 30

200. Gobius würdemanni Grd. Brazos Santiago (types, Girard, 1859, and Synopsis).

201. Gobionellus oceanicus (Pallas). *Emerald Fish.* St. Joseph Island (as *Gobionellus hastatus* types, Girard, 1859, pl. XII, figs. 7 and 8).

202. Lepidogobius gulosus (Grd.). *Goby.* Indianola (as *Gobius gulosus* types, Girard, 1858 and 1859, and Synopsis). Taken by us at Corpus Christi and in Dickinson Bayou near Dickinson.

203. Gobiosoma bosci (Lac.). *Goby.* Five specimens from Galveston and nineteen from Corpus Christi.

204. Gobiosoma molestum Grd. *Goby.* Indianola (type, Girard, 1859, pl. XII, fig. 14). Six specimens are in our collection from Corpus Christi.

XL.—TRIGLIDÆ. THE GURNARDS.

205. Prionotus scitulus J. & G. *Sea Robin.* Taken by us only at Galveston.

206. Prionotus tribulus C. & V. *Sea Robin.* Galveston (Jordan & Gilbert, 1882). Taken by us at Galveston and Corpus Christi.

XLI.—GOBIESOCIDÆ.

207. Gobiesox virgatulus J. & G. One specimen, 1⅝ inches long to tip of caudal, taken at Galveston. Head (from tip of snout to edge of gill-cover), about 2⅝; width of head, 3¼; depth, 7¼; D. 10; A. 6. Body slender, head low and broad. Eye small, 4½ in head or 2 in interorbital width. Cheeks not prominent; opercle ending in a sharp spine; cleft of mouth extending below front of orbit; teeth of upper jaw in two series, the outer series short, those occupying front of jaw enlarged, four of which are canine-like. Eight middle teeth of lower jaw incisor-like, edges entire. Color, dark olivaceous, indistinctly mottled and finely punctate; under part of head, disk, and ventrals pale and yellowish; dorsal, caudal, and anal dark, barred with paler; belly yellowish brown. This specimen seems to be *G. virgatulus*, but the fin rays are fewer than in that species.

XLII.—BATRACHIDÆ. THE TOADFISHES.

208. Batrachus tau (L.). *Toadfish; Oyster-fish.* Indianola (Girard, 1859). One example obtained by us at Corpus Christi.

209. Porichthys porosissimus (C. & V.). Galveston (as *Porichthys plectrodon* types, Jordan & Gilbert, 1882).

XLIII.—URANOSCOPIDÆ. THE STAR-GAZERS.

210. Upsilonphorus y-græcum (C. & V.). *Star-gazer.* One specimen of this species was secured by us at Galveston.

211. Astroscopus anoplos (C. & V.). *Dogfish. Electric Dogfish.* Galveston (Jordan & Gilbert, 1882), where they report it as being rather common.

XLIV—BLENNIIDÆ. THE BLENNIES.

212. **Chasmodes bosquianus** (Lac.). *Blenny*. Three specimens obtained by us at Corpus Christi.

213. **Isesthes hentzi** (Le S.). *Blenny*. We collected two specimens at Corpus Christi.

214. **Isesthes ionthas** J. & G. *Blenny*. Apparently not common on the Texas coast, as it has not hitherto been reported from that coast and we obtained but a single specimen at Galveston.

215. **Isesthes scrutator** J. & G. *Blenny*. Galveston (types, Jordan & Gilbert, 1882).

216. **Hypleurochilus geminatus** (Wood). *Blenny*. St. Joseph Island (as *Blennius multifilis* types, Girard, 1859, pl. XII, fig. 6).

XLV.—OPHIDIIDÆ. THE OPHIDIOIDS.

217. **Ophidion marginatum** DeKay. St. Joseph Island (as *Ophidion josephi* types, Girard, 1859, and Synopsis).

XLVI.—PLEURONECTIDÆ. THE FLOUNDERS.

218. **Citharichthys spilopterus** Günther. *Flounder*. Taken by us at Galveston.

219. **Etropus crossotus** J. & G. Galveston (Jordan & Gilbert, 1882). Ten specimens obtained by us at Galveston.

220. **Paralichthys lethostigma** J. & G. *Flounder*. A common market fish at Galveston (as *Paralichthys dentatus*, Jordan & Gilbert, 1882). Found by us at Galveston, Dickinson Bayou, and Corpus Christi.

221. **Ancylopsetta quadrocellata** Gill. We have two small specimens taken at Galveston.

222. **Achirus fasciatus** Lac. Galveston (as *Achirus lineatus browni*, Jordan & Gilbert, 1882). One young individual from Galveston and another from Dickinson Bayou near Dickinson.

223. **Symphurus plagiusa** (L.). Found by us at Galveston, Dickinson Bayou, and Corpus Christi. It does not appear at all abundant, as we obtained but four specimens.

XLVII.—ANTENNARIIDÆ. THE FROGFISHES.

224. **Pterophryne histrio** (L.). Galveston (as *Pterophrynoides histrio*, Jordan & Gilbert, 1882). One specimen from Galveston, presented to us by Dr. A. Galny.

XLVIII.—MALTHIDÆ. THE BATFISHES.

225. **Malthe vespertilio** (L.). A specimen of this fish was given to Dr. Jordan by Dr. A. Galny, of Galveston (Jordan & Gilbert, 1882).

XLIX.—OSTRACIIDÆ. THE TRUNKFISHES.

226. **Ostracion tricorne** L. *Cowfish*. Galveston, one specimen (as *Ostracium quadricorne*, Jordan & Gilbert, 1882).

L.—BALISTIDÆ. THE TRIGGER-FISHES.

227. **Alutera schœpfii** (Walb.). *Orange Filefish*. Through the kindness of Mr. J. A. Singley, of the Texas Geological Survey, we have received a dry skin of this species. Mr. Singley obtained the specimen at Galveston, where it is known as the "orange filefish." A young fish, probably of this species, was seen by Dr. Jordan at Galveston (as *Alutera* sp. incog., Jordan & Gilbert, 1882).

LI.—TETRODONTIDÆ. THE PUFFERS.

228. **Lagocephalus lævigatus** (L.). One specimen obtained by Dr. Jordan at Galveston (Jordan & Gilbert, 1882).

229. **Tetrodon nephelus** (Goode & Bean). *Swellfish; Puffer*. Abundant at Galveston (as *Tetrodon turgidus nephelus*, Jordan & Gilbert, 1882). One specimen taken by us at Galveston and one at Corpus Christi.

230. **Chilomycterus schœpfii** (Walb.). Common about Galveston (Jordan & Gilbert, 1882).

CLASSIFIED LIST OF LOCALITIES MENTIONED.

In the following classified list of streams and localities an attempt has been made to arrange in order all the localities in Texas and the Rio Grande Basin from which any fish has ever been reported, as shown by the literature at our command. Some of the small creeks and springs mentioned in the earlier papers are quite difficult to locate definitely, but it is believed the classification here given is approximately, if not exactly, correct. It has been thought best to include, in a few cases, localities not in the actual limits of this paper, the object of which will be apparent upon an examination of the preceding detailed list of species. Isolated waters south of the Rio Grande, but which geographically belong in the Rio Grande Basin, have been included:

- Arkansas River:
  - Canadian River.
    - Spring Creek near Creswell.
    - Fulton Creek near Creswell.
    - Coal Creek.
    - Headwaters of Canadian River in the Llano Estacado.
    - Elm Creek.
    - Antelope Creek.
  - Poteau River near Fort Smith, Arkansas.
- Red River at Fulton, Arkansas.
  - Tributary of Red River at Fort Washita, Indian Territory.
  - Otter Creek, tributary of North Fork.
  - Gypsum Creek.
  - Sans Bois Creek.
  - Little Wichita River.
  - Turkey Creek.
- Sabine River at Longview.
- Neches River near Palestine.
- Trinity River at Fort Worth, Dallas, Magnolia Point, and at mouth.
  - Long Lake near Magnolia Point.
  - Elm Creek.
- San Jacinto River at Lynchburg.
- Buffalo Bayou near Houston.
  - Hunter Creek near Houston.
  - Big White Oak Bayou near Houston.
  - Sims Bayou near Houston.
  - Kilper's Pond near Houston.
- Dickinson Bayou at Nicholstone.
- Brazos River.
  - Clear Creek near Hempstead.
  - Leon River.
  - Lampasas River near Belton.
- Colorado River, headwaters of.
  - San Saba River at Fort McKavett.
  - Llano River in Kimble County.
  - Johnson Fork, in Kimble County.
  - Comanche Creek in Mason County.
- San Antonio River at San Antonio.
  - Guadalupe River at New Braunfels.
    - Comal Creek at New Braunfels.
    - Blanco River at San Marcos.
    - San Marcos River at San Marcos.
    - Dry Creek near Victoria.
  - Cibolo Creek.
    - Sutherland Springs.
  - Medina River at Helotes.
    - Tributary of Medina River.
    - Helotes Creek.
    - Wallace Creek in Bandera County, and the upper waters of Medina River.
  - Salado River.
  - San Antonio Springs, San Antonio.
  - San Pedro Creek, San Antonio.
- Nueces River.
  - Frio River.
    - Sabinal, Leona, and Seco rivers.
  - Upper tributaries of Nueces River.
  - Elm Creek.
  - Turkey Creek.
- Rio Grande at Alamosa, Loma, Sangre de Christo Pass, and (tributary) at Fort Garland in Colorado; San Ildefonso, at the mouth of the Hondo River, Albuquerque, Piedra Painte; (tributary) at Ojo de Gallo, (tributary) between Fort Defiance and Fort Union, (tributary) at Zoquito, and Fort Bliss in New Mexico; (tributaries) at Buena Vista, Acapulco, and Cuajuco, New Leon; Parras, and spring near Saltillo, Coahuila; (lagoon) at Palo Alto, Matamoras, and Boca Grande in Tamaulipas; Eagle Pass (lagoon), Fort Brown, and Brownsville in Texas.
  - San Felipe Creek.
    - San Felipe Springs.
  - Devil River.
  - Pecos River.
    - Live Oak Creek.
    - Headwaters of Pecos River.
    - Bonito River, New Mexico.
    - Delaware Creek.
    - Limpia River and Springs.
    - Comanche Springs.
    - Leon Springs.
    - Hurrah Creek.
  - Taos River, New Mexico.
  - Costilla Creek, New Mexico.
  - Rio Conejos at Alamosa, Colorado.
  - Chama River.
    - Tributary, at Abiquiu, New Mexico.
    - Brazos River, New Mexico.
  - (?) Rio de Acama, New Mexico.
  - Utah Creek.
  - Lake Guzman.
    - Tributaries.
    - Rio Mimbres in Chihuahua.
    - Janos River.
    - Streams of the Sierra Madre.
  - Chihuahua River and tributaries.
  - Rio de las Conchas, Chihuahua.
  - Chihuahua near northern boundaries of Durango and Sinaloa.
  - Lago del Muerte, tributaries and springs near Monclova, Coahuila.
    - Nazas River at San Pedro.
  - Rio San Juan at China, and near Monterey, New Leon.
    - Rio San Diego near Cadereita, New Leon.

APPENDIX.

While carrying on the investigations for the purpose of selecting a site for a fish-cultural station in Texas in November and December, 1891, a considerable collection of mollusks and a small collection of reptiles and batrachians were made. The mollusks were collected almost wholly by Dr. R. R. Gurley, of the U. S. Fish Commission, and Mr. J. A. Singley, of the Texas geological survey, who accompanied our party during most of the time spent by us in the State. The large number of species found in the accompanying list attests their skill and enthusiasm as collectors. As many of these mollusks sustain an important relation to the fishes of the region in which they are found, the list may very properly be published here. No special search was made for reptiles and batrachians, but such as we chanced to see were collected and preserved. These were turned over to the National Museum, where they have been studied by Mr. F. C. Test, whose report is herewith presented.

ANNOTATED LIST OF THE REPTILES AND BATRACHIANS COLLECTED IN MISSOURI AND TEXAS IN THE FALL OF 1891.

[By Frederick C. Test, Aid, Reptile Department, U. S. National Museum.]

Texas is well known to abound in reptiles, but nearly all the species had gone into hibernation at the time of this expedition (November and December) and few were therefore seen. The list is of value, however, in that it shows what species of reptiles and batrachians of that region are to be seen so late in the fall. The four turtles collected are very interesting, and, taking everything into consideration, the entire collection, though small, is one of some importance.

1. **Malaclemmys kohnii** Baur. Four young turtles were captured, and are of especial note. They are different from any other species of this group, even differing in some of the markings on the head from this recently described species to which I have referred them. The slight differences, however, seem to me due to immaturity, and I therefore refer these four specimens to *M. kohnii*. The find extends the range of the species some little distance to the west of the type locality in southern Louisiana.

Museum No.	Collector's No.	Locality.	Date.
17692	11	Long Lake, near Trinity River, 12 miles southwest of Palestine, Tex.	Nov. 25
17693	12		
17694	13		
17695	14		

2. **Anolis principalis** L. One adult female of this so-called "chameleon," found in abundance in several Southern States, especially the adjoining one of Louisiana, was collected.

Museum No.	Collector's No.	Locality.	Date.
17696	4	Neches River, 14 miles east of Palestine, Tex.....	Nov. 24

3. **Sceloporus undulatus** Daudin. This widely spread lizard is represented in the collection by one young individual.

Museum No.	Collector's No.	Locality.	Date.
17697	5	Neches River, 14 miles east of Palestine, Tex....	Nov. 24

4. **Carphophiops vermis** Kenn. One half-grown specimen of this retiring ground snake was obtained in southwestern Missouri. The salmon color of the under surface is particularly bright.

Museum No.	Collector's No.	Locality.	Date.
17698	2	U. S. Fish Commission Station, Neosho, Mo	Oct. 30

5. **Storeria dekayi** Holbrook. One specimen of this little snake, which seems to be quite commonly found at this time of year about water-courses, in the bottoms of ditches, and similar places, sometimes occurring dozens together, of all ages and sizes. In this individual the ground color is a shade lighter than usual, bringing out clearly the dark spots and markings, noticeably those about the head.

Museum No.	Collector's No.	Locality.	Date.
17699	3	New Braunfels, Tex..............................	Dec. 2

6. **Spelerpes bilineatus** Green. One very small specimen was secured, still possessing gills and cirri. It is quite dark. This is the only salamander found.

Museum No.	Collector's No.	Locality.	Date.
17700	6	Neches River, 14 miles east of Palestine, Tex ...	Nov. 24

7. **Acris gryllus crepitans** Baird. Of this common little frog, or "peep," five specimens were collected. Nos. 17701, 17704, and 17705 are very typically and finely marked, but Nos. 17702 and 17703, in addition to the usual markings, have several small, circular, light spots on the back, giving them an odd, mottled appearance.

Museum No.	Collector's No.	Locality.	Date.
17701	7	Sims Bayou, 10 miles south of Houston, Tex....	Nov. 18
17702	8	Big White Oak Bayou, 2 miles northwest of Houston, Tex.	Nov. 17
17703	9		
17704	10	New Braunfels, Tex..............................	Dec. 3
17705	19	......do	Do.

8. **Rana pipiens pipiens** Schreber. One large specimen of typical proportions, but with unusually dark coloration. The ground color is quite dusky, and the posterior surfaces of the thighs are broadly mottled with black. The throat and front of femurs are flecked with brownish. This phase of coloring, though apparently not common, is paralleled by U. S. N. M. No. 3293, from Brownsville, Tex., collected by Capt. Van Vliet.

Museum No.	Collector's No.	Locality.	Date.
17706	18	New Braunfels, Tex	Dec. 3

9. **Rana catesbiana** Shaw. One medium-sized, quite dark specimen, with the under surface thoroughly marbled with dark brown, and nine tadpoles of this species were collected.

Museum No.	Collector's No.	Locality.	Date.
17707	15	Neches River, 14 miles east of Palestine, Tex.....	Nov. 24
17708-13	16	Trinity River, at Magnolia Point, 10 miles southwest of Palestine, Tex.	Nov. 23
17714-16	17	New Braunfels, Tex..............................	Dec. 3

LIST OF MOLLUSCA COLLECTED IN TEXAS IN 1891.

[By J. A. Singley, Geological Survey of Texas.]

The collection of mollusca, of which a list is given below, was made by Dr. R. R. Gurley and the writer, while engaged in investigating the waters of Texas with the view of establishing a fish-cultural station in that State. No new species are described, but a new *Cytherea* (*C. texasiana*) has been described by Dr. W. H. Dall from material collected at Galveston during the investigation. The list also includes a number of marine species not heretofore recorded from the State, and gives new localities for several terrestrial and fluviatile species. The arrangement is that of Tryon's "Structural and Systematic Conchology."

1. **Spirula peronii** Lam. Galveston and Corpus Christi.
2. **Purpura hæmastoma** L. Galveston and Corpus Christi. It is abundant on the rocks at the Galveston jetty.
3. **Fasciolaria gigantea** Kien. Corpus Christi. Given on the authority of Dr. Gurley. I have not seen the species.
4. **Fulgur perversa** L. Corpus Christi and Galveston. Common at both places.
5. **Fulgur pyrum** Dillwyn. Galveston and Corpus Christi. Not common.
6. **Nassa vibex** Say. Galveston; beach-worn examples. Abundant, living at Corpus Christi, in Corpus Christi Bay and Laguna Madre. The Texas examples are dwarfed.
7. **Nassa acuta** Say. Common on Galveston Beach the latter part of November. A few beach-worn examples were found at Corpus Christi.
8. **Olivella mutica** Say. Beach-worn examples were found at Galveston.
9. **Oliva literata** Lam. A few broken shells found on Galveston Beach.
10. **Anachis obesa** C. B. Ad. Galveston and Corpus Christi; dead shells, not rare.
11. **Astyris lunata** Say. Dead and worn shells common on Galveston Beach, abundant living at Shamrock Cove, Corpus Christi Bay.
12. **Terebra concava** Say. Galveston Beach; not common; dead and worn shells only.
13. **Terebra dislocata** Say. Galveston Beach; commoner than the preceding and better preserved.
14. **Mangilia cerinella** Dall. Common at Galveston and Corpus Christi.
15. **Natica duplicata** Say. Galveston and Corpus Christi. An elevated and a depressed form are found. Common.
16. **Natica pusilla** Say. Galveston; beach-worn examples only. Not common.
17. **Sigaretus perspectivus** Say. Common on Galveston Beach.
18. **Crepidula fornicata** L. Abundant at Corpus Christi. A few found on Galveston Beach.
19. **Crepidula plana** Say. Galveston and Corpus Christi. Common.
20. **Crepidula convexa** Say. Corpus Christi. The species is given on the authority of Dr. Gurley.
21. **Solarium verrucosum** Phil. Galveston Beach, rare. Padre Island, Corpus Christi Bay, common.
22. **Scala contorquata** Dall. Galveston. Given on the authority of Dr. Gurley.
23. **Turbonilla interrupta** Totten. Galveston Beach. Not common.
24. **Litorina irrorata** Say. Abundant along the shore of Galveston Bay near Swan Lake.
25. **Modulus lenticularis** Chem. Corpus Christi. Given on the authority of Dr. Gurley.
26. **Cerithium variabile** C. B. Ad. Abundant in Shamrock Cove, Corpus Christi Bay.
27. **Bittium varium** Pfr. Galveston and Corpus Christi; abundant.
28. **Bittium cerithidioides** Dall. Galveston (Dr. Gurley).
29. **Seila terebralis** C. B. Ad. Dead shells found on the beach near Corpus Christi.
30. **Goniobasis pleuristriata** Say. Comal Creek, New Braunfels. The species is not common.
31. **Goniobasis comalensis** Pilsbry. Comal Springs and Guadalupe River, New Braunfels; San Marcos Springs and River, San Marcos. Abundant.
32. **Hydrobia texana** Pilsbry. Comal Creek, New Braunfels. Not common.
33. **Pyrgula spinosa** Call & Pilsbry. Comal Creek, New Braunfels. Rare.
34. **Amicola peracuta** Pilsbry & Walker. Comal Creek, New Braunfels; Long Lake, Anderson County. Abundant.
35. **Truncatella caribbaënsis** Sowb. Galveston.

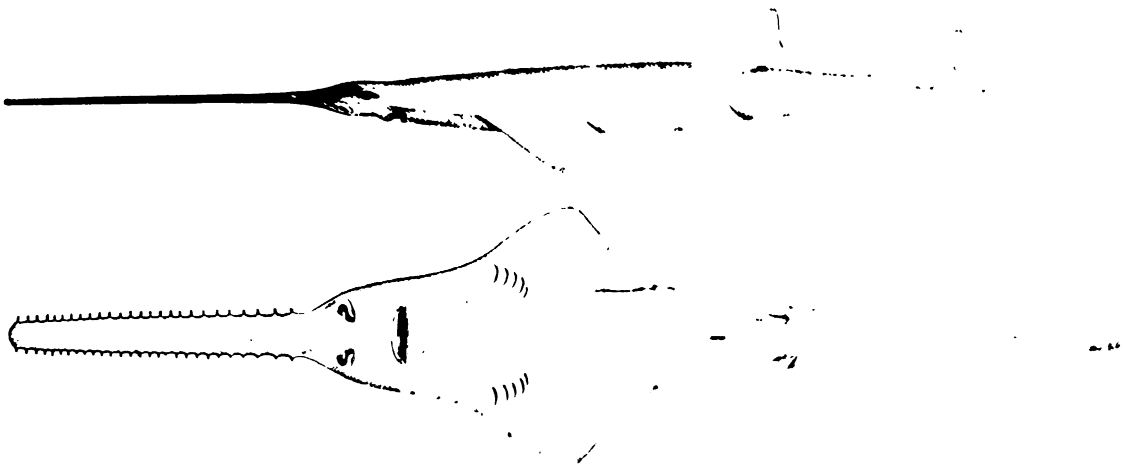
36. **Truncatella pulchella** Pfr. Galveston. These two species of *Truncatella* are listed on the authority of Dr. Gurley. I have not found them in my Galveston material.
37. **Helicina orbiculata** Say. This species was found abundant at every point visited with the exception of Galveston Island.
38. **Fissurella alternata** Say. A few bleached and broken examples were found on the beach near Corpus Christi.
39. **Actæon punctostriatus** C. B. Ad. Galveston and Corpus Christi. Not common.
40. **Utriculus canaliculatus** Say. Galveston and Corpus Christi. Common.
41. **Bulla occidentalis** A. Ad. Corpus Christi. Dead shells abundant.
42. **Glandina decussata** Desh. var. **singleyana** W. G. Binney. One example found at New Braunfels.
43. **Zonites indentatus** Say. var. **umbilicata**. San Marcos, San Antonio, New Braunfels, and Palestine. Common.
44. **Zonites arboreus** Say. Found at same localities as the above, but much more abundant.
45. **Zonites fulvus** Drap. New Braunfels. Common.
46. **Zonites minusculus** Binn. New Braunfels. Common.
47. **Zonites singleyanus** Pilsbry. New Braunfels. Not common.
48. **Helix berlandieriana** Mor. Houston and Palestine. Common.
49. **Helix griseola** Pfr. Corpus Christi, San Antonio, and Austin. Abundant.
50. **Helix roemeri** Pfr. Austin. Abundant.
51. **Helix monodon** Rack. var. **fraterna** Say. New Braunfels. Common.
52. **Helix texasiana** Mor. Palestine, Austin, San Marcos, San Antonio, and Corpus Christi. Abundant.
53. **Helix mooreana** W. G. Binn. New Braunfels. Abundant.
54. **Helix hippocrepis** Pfr. New Braunfels. Rare.
55. **Helicodiscus lineatus** Say. New Braunfels. Not common.
56. **Bulimulus alternatus** Say. Corpus Christi. Typical *alternatus* was found west of Corpus Christi, while a variety intermediate between *alternatus* and *schiedeanus* was found along the bluffs bordering on Corpus Christi Bay.
57. **Bulimulus dealbatus** Say. Palestine. Two examples.
58. **Bulimulus schiedeanus** Pfr. New Braunfels and San Antonio. Common.
59. **Bulimulus schiedeanus mooreanus** W. G. Binn. San Antonio, New Braunfels, San Marcos, and Austin. Abundant. These so-called "species" of *Bulimulus* are simply variations of one species. At each of the given localities examples were found that connected two or more forms and could not be satisfactorily referred to any one "species."
60. **Holospira roemeri** Pfr. New Braunfels. Very rare.
61. **Holospira goldfussi** Menke. New Braunfels. Common.
62. **Macroceramus gossei** Pfr. New Braunfels. Common.
63. **Pupa fallax** Say. New Braunfels. Abundant.
64. **Pupa procera** Gould. New Braunfels. Common.
65. **Pupa contracta** Say. Palestine, New Braunfels. Common.
66. **Pupa pentodon** Say. New Braunfels. Common.
67. **Pupa curvidens** Gould. New Braunfels. Not common.
68. **Pupa armifera** Say. New Braunfels. Two examples.
69. **Succinea grosvenori** Lea. Palestine. Rare.
70. **Physa forsheyi** Lea. Long Lake, Anderson County. Not common.
71. **Physa halei** Lea. San Antonio Springs and San Marcos springs and river; also in Comal Creek, New Braunfels. Abundant.
72. **Limnæa humilis** Say. Long Lake, Anderson County. Not common.
73. **Limnæa desidiosa** Say. San Antonio Springs, San Antonio; San Marcos Springs and River, San Marcos. Not common.
74. **Planorbis liebmanni** Dunker. Comal Creek, New Braunfels. Common.
75. **Planorbis lentus** Say. Long Lake, Anderson County; Comal Creek, New Braunfels. Common.
76. **Planorbis bicarinatus** Say. San Marcos River, San Marcos. Not common.
77. **Ancylus excentricus** Morelet. Comal Creek, New Braunfels. Very rare.
78. **Pholas truncata** Say. Corpus Christi. Not common.
79. **Pholas costata** L. Single valves abundant at Galveston and Corpus Christi.
80. **Solen directus** Conrad. Corpus Christi. Young shells abundant. No adults were found.
81. **Tagelus gibbus** Spengler. Galveston and Corpus Christi. Common.
82. **Mactra lateralis** Say. Corpus Christi and Galveston. Abundant.

83. **Mactra braziliana** Lam. Corpus Christi (Dr. Gurley).
84. **Gnathodon cuneata** Con. Corpus Christi and Galveston. Abundant. The Givens Oyster Company, at Corpus Christi, were canning this species and putting it on the market labeled "Little Neck Clams."
85. **Gnathodon rostrata** Petit. Galveston (Dr. Gurley).
86. **Labiosa canaliculata** Say. Single valves are abundant at Corpus Christi and Galveston.
87. **Semele reticulata** Gmel. Galveston (Dr. Gurley).
88. **Abra æqualis** Say. Galveston. Not common.
89. **Cumingia tellinoides** Con. Corpus Christi. Not common.
90. **Tellina alternata** Say. Galveston and Corpus Christi. Abundant.
91. **Tellina polita** Say. Corpus Christi (Dr. Gurley).
92. **Macoma constricta** Brug. Galveston and Corpus Christi. Not common.
93. **Macoma brevifrons** Say. Galveston (Dr. Gurley).
94. **Donax tumida** Retz. Galveston and Corpus Christi. Abundant.
95. **Donax roemeri** Pfr. Galveston and Corpus Christi. Not common.
96. **Petricola pholadiformis** Lam. Single valves were found at Galveston and Corpus Christi.
97. **Venus cancellata** L. Dead shells are very abundant on the beach at Corpus Christi. A few beach-worn shells found at Galveston.
98. **Venus mercenaria** L. Corpus Christi (Dr. Gurley).
99. **Venus mercenaria** L. var. **mortoni** Con. Galveston and Corpus Christi. Common.
100. **Venus rostrata** Sowb. Corpus Christi. Common.
101. **Cytherea texasiana** Dall. Galveston. Single valves are not uncommon on Galveston beach.
102. **Cytherea gigantea** Gmel. Galveston and Corpus Christi. Common.
103. **Dosinia discus** Reeve. Galveston and Corpus Christi. Common.
104. **Pisidium compressum** Prime. Comal Creek, New Braunfels. Common.
105. **Sphærium singleyi** Pilsbry. White Oak Bayou, Houston; Guadalupe River, New Braunfels. Not common.
106. **Cardium musicatum** L. Galveston and Corpus Christi. Single valves are common.
107. **Cardium magnum** Born. Galveston and Corpus Christi. Abundant.
108. **Lævicardium mortoni** Con. Abundant, living in Corpus Christi Bay. Single valves only found at Galveston.
109. **Lucina crenulata** Con. Single valves abundant in the beach drift at Corpus Christi.
110. **Unio undulatus** Barnes. San Antonio River at the waterworks station, San Antonio. Two odd valves only were found.
111. **Unio asper** Lea. Long Lake, Anderson County. Abundant.
112. **Unio texasensis** Lea. Long Lake, Anderson County. Common.
113. **Anodonta stewartiana** Lea. Long Lake, Anderson County. A number of fine examples of this species were taken.
114. **Leda concentrica** Say. Single valves common at Galveston and Corpus Christi.
115. **Arca ponderosa** Say. Beach-worn valves are common at Galveston and Corpus Christi.
116. **Arca transversa** Say. Single valves common at Galveston and Corpus Christi.
117. **Arca incongrua** Say. Galveston and Corpus Christi. Abundant.
118. **Arca pexata** Say. A few valves found at Galveston.
119. **Arca americana** Gray. Corpus Christi (Dr. Gurley).
120. **Mytilus cubitus** Say. Corpus Christi. Common on oysters.
121. **Mytilus hamatus** Say. Galveston and Corpus Christi. Very abundant on oyster reefs.
122. **Modiola plicatula semicostata** Conrad. A fine large example was taken in Galveston Bay (near the bayou connecting Swan Lake with the bay) while seining in shallow water there.
123. **Pinna muricata** L. A few valves found at Corpus Christi.
124. **Plicatula ramosa** Lam. Galveston (Dr. Gurley).
125. **Pecten irradians** Lam. Beach-worn valves are common at Galveston and Corpus Christi.
126. **Pecten irradians dislocatus** Say. Same distribution and abundance as *P. irradians*. I found it living in Corpus Christi Bay.
127. **Anomia simplex** Orbigny. Single valves are washed up on the beach at Galveston. A number were found living at Corpus Christi.
128. **Ostrea virginica** Gmel. The most common mollusk on the Texas coast. For a discussion of the commercial phase of the oyster industry on the Texas coast, see Mr. C. H. Stevenson's paper in the report of the U. S. Commissioner of Fish and Fisheries for 1889-91.

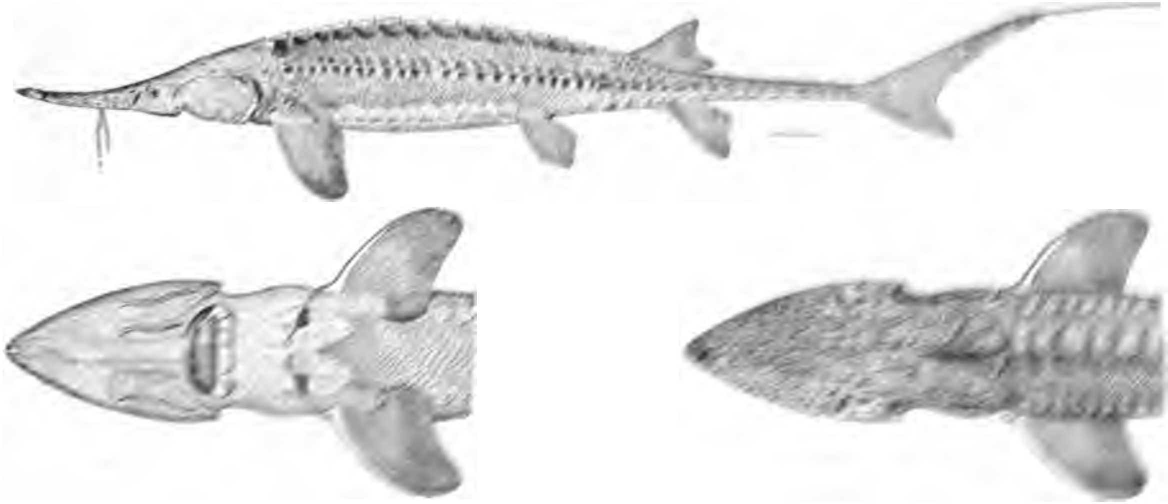
EXPLANATION OF PLATES.

The 50 plates which follow give illustrations of 107 of the 230 species of fishes now known to occur in the waters of Texas and the Rio Grande basin. The species are arranged substantially in the order in which they come in the text. Under each illustration are given: (1) the scientific name; (2) the common name, the more generally accepted in italics, those of local use in roman; (3) the locality, when known, from which the specimen drawn was obtained; (4) the name of the artist who made the original drawing. Many of these drawings were made several years ago by Mr. H. L. Todd. A few others were made by Mr. William Haines, Miss M. Smith, and Mr. S. F. Denton. The remaining 17 species were drawn by Mr. A. H. Baldwin especially for this paper.

Plate No.	
X.	*Pristis pectinatus.* Sawfish.
	Scaphirhynchus platyrhynchus. Shovel-nosed Sturgeon.
	Lepisosteus platystomus. Short-nosed Gar.
XI.	*Noturus nocturnus.*
	Leptops olivaris. Yellow Cat; Mud Cat.
	Ameiurus melas. Bullhead.
XII.	*Ameiurus nebulosus catulus.*
	Ameiurus natalis. · Yellow Cat.
	Ameiurus lupus.
XIII.	*Ictalurus furcatus.* (From type of *Pimelodus affinis* Grd.) Chuckle-head Cat; Blue Cat.
	Ictalurus punctatus. Channel Cat; Eel Cat.
	Tachysurus felis. Sea Catfish.
XIV.	*Felichthys marinus.* Gaff-topsail.
	Ictiobus cyprinella. Common Buffalo-fish.
	Carpiodes carpio. Carp Sucker.
XV.	*Catostomus teres.* Common White Sucker.
	Erimyzon sucetta. Chub Sucker; Creek Sucker.
	Minytrema melanops. Striped Sucker.
XVI.	*Moxostoma congestum.*
	Campostoma anomalum. Stone-roller.
	Notropis cayuga atrocaudalis. Type.
XVII.	*Notropis nux.* Type.
	Notropis nocomis. Type.
	Notropis swaini.
XVIII.	*Notropis fumeus.* Type.
	Notropis notemigonoides. Type.
	Rhinichthys dulcis. Dace.
XIX.	*Hybopsis æstivalis marconis.*
	Semotilus atromaculatus. Horned Dace.
	Opsopœodus oscula. Type.
XX.	*Notemigonus chrysoleucus.* Bream.
	Megalops atlanticus. Tarpon.
	Clupea chrysochloris. Skipjack.
XXI.	*Brevoortia tyrannus patronus.* Gulf Menhaden.
	Dorosoma cepedianum. Gizzard Shad.
	Synodus fœtens. Lizard-fish.
XXII.	*Salmo mykiss spilurus.* Rio Grande Trout.
	Cyprinodon variegatus. Variegated Minnows.
XXIII.	*Fundulus pallidus.* Type.
	Fundulus zebrinus.
	Fundulus diaphanus, Spring Minnow.
XXIV.	*Zygonectes funduloides.* Type.
	Zygonectes pulvereus. Type.
	Zygonectes jenkinsi. Type.
	Zygonectes notatus: Top Minnow.
XXV.	*Lucania parva.*
	Gambusia affinis.
	Lucius vermiculatus. Little Pickerel.
XXVI.	*Gymnothorax ocellatus nigromarginatus.* Type.
	Anguilla chrysypa. Common Eel.
XXVII.	*Hemirhamphus unifasciatus.* Half-beak.
	Mugil cephalus. Common Mullet.
	Polynemus octonemus Threadfin.
XXVIII.	*Vomer setipinnis.* Moonfish.
	Selene vomer. Silver Moonfish.
XXIX.	*Caranx hippos.* Horse Crevallé.
	Chloroscombrus chrysurus. Bumper.
XXX.	*Trachynotus carolinus.* Pompano.
	Aphredoderus sayanus. Pirate Perch.
XXXI.	*Pomoxis annularis.* Crappie.
	Pomoxis sparoides. Calico Bass.
XXXII.	*Chænobryttus gulosus.* Warmouth.
	Lepomis symmetricus.
XXXIII.	*Lepomis megalotis,* Large-eared Sunfish.
	Lepomis pallidus. Blue Sunfish; Blue-gill.
XXXIV.	*Micropterus salmoides.* Large-mouthed Black Bass.
	Etheostoma pellucidum clarum. Sand Darter.
	Etheostoma chlorosoma.
XXXV.	*Etheostoma micropterus.*
	Etheostoma caprodes. Log Perch.
	Etheostoma lepidogenys. Type.
XXXVI.	*Etheostoma shumardi.*
	Etheostoma jessiæ.
	Etheostoma fusiforme.
	Etheostoma fonticola.
XXXVII.	*Centropomus undecimalis.* Robalo.
	Morone interrupta. Yellow Bass.
	Roccus chrysops. White Bass.
XXXVIII.	*Lutjanus caxis.* Gray Snapper.
	Lutjanus aya. Red Snapper.
XXXIX.	*Rhomboplites aurorubens.* Mangrove Snapper.
	Orthopristis chrysopterus. Hogfish.
XL.	*Archosargus probatocephalus.* Sheepshead.
XLI.	*Lagodon rhomboides.* Pinfish.
	Aplodinotus grunniens. Fresh-water Drum.
XLII.	*Pogonias chromis.* Drum.
	Bairdiella chrysura. Yellow-tail.
XLIII.	*Sciæna ocellata.* Red Drum; Redfish.
	Micropogon undulatus. Croaker.
	Menticirrihus americanus. Whiting.
XLIV.	*Leiostomus xanthurus.* Spot.
	Cynoscion nothus.
	Cynoscion nebulosus. Spotted Sea Trout.
XLV.	*Chætodypterus faber.* Angel-fish.
	Gobionellus oceanicus. Emerald-fish.
XLVI.	*Prionotus scitulus.* Sea Robin.
	Upsilonphorus y-græcum. Star-gazer.
	Astroscopus anoplos. Electric Dogfish.
XLVII.	*Isesthes ionthas.* Blenny.
	Ophidion marginatum.
	Etropus crossotus.
XLVIII.	*Paralichthys lethostigma.* Southern Flounder
	Ancylopsetta quadrocellata.
XLIX.	*Ostracion tricorne.* Cowfish.
	Alutera schœpfi. Orange Filefish.
	Lagocephalus lævigatus. Smooth Puffer.
L.	*Tetrodon nephelus.* Swellfish; Puffer.
	Chilomycterus schœpfi. Swelltoad; Burrfish.



PRISTIS PECTINATUS Latham. *Sawfish.* Side and ventral views. Pensacola, Florida. [illegible]



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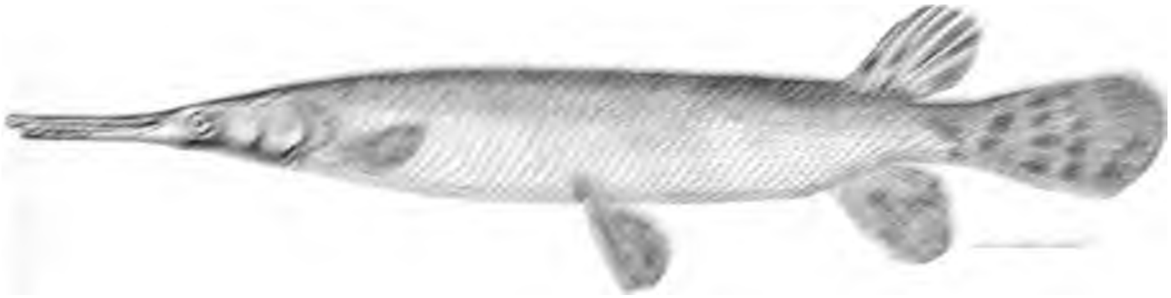

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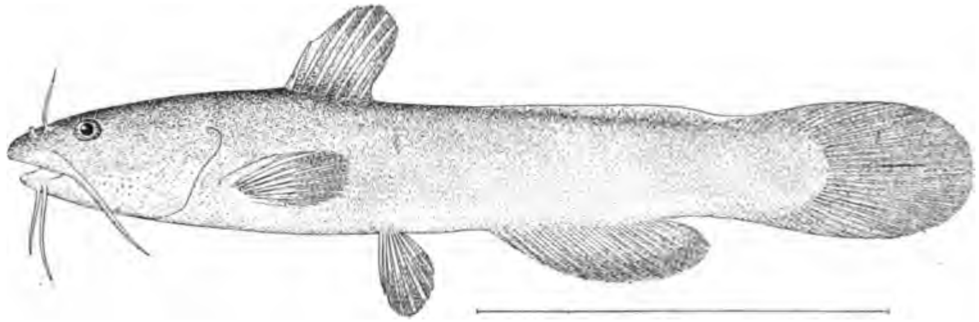
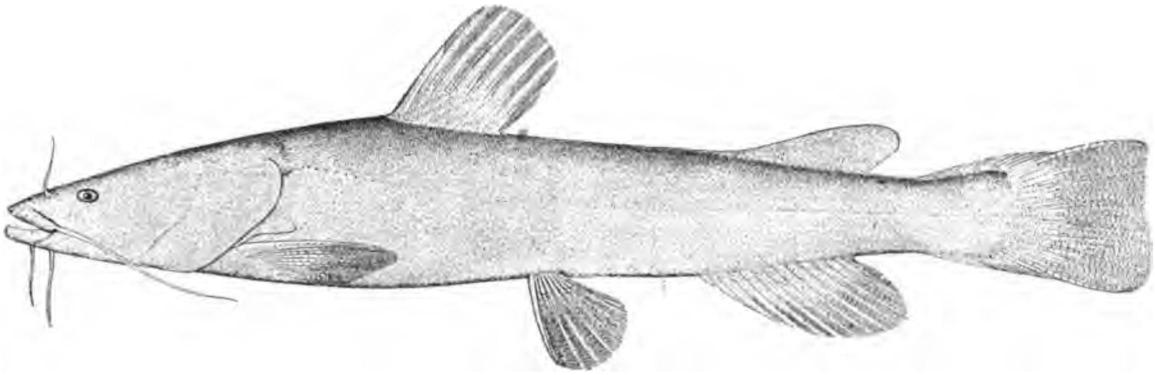
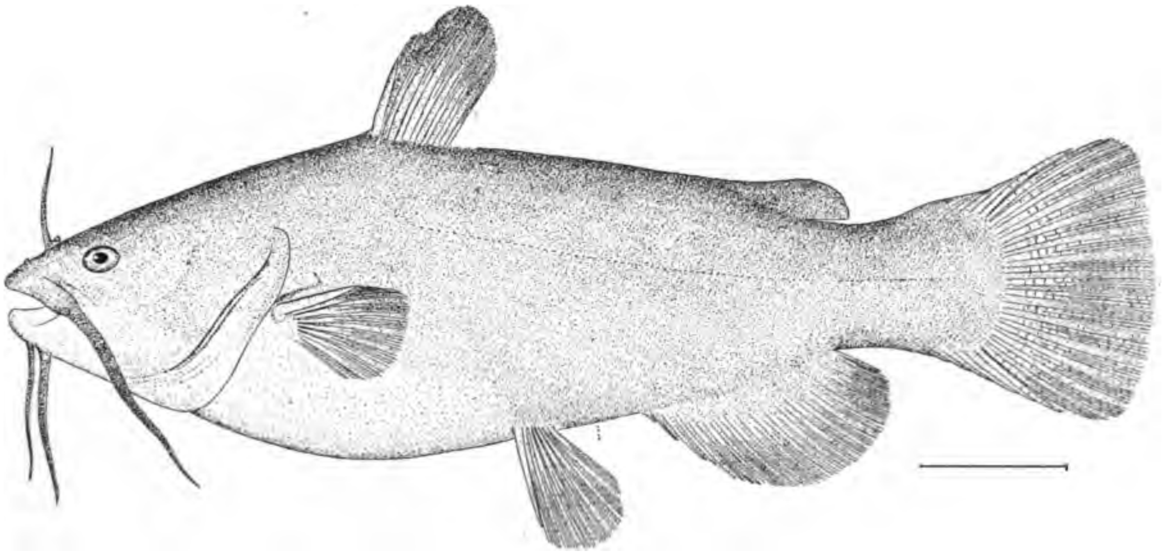


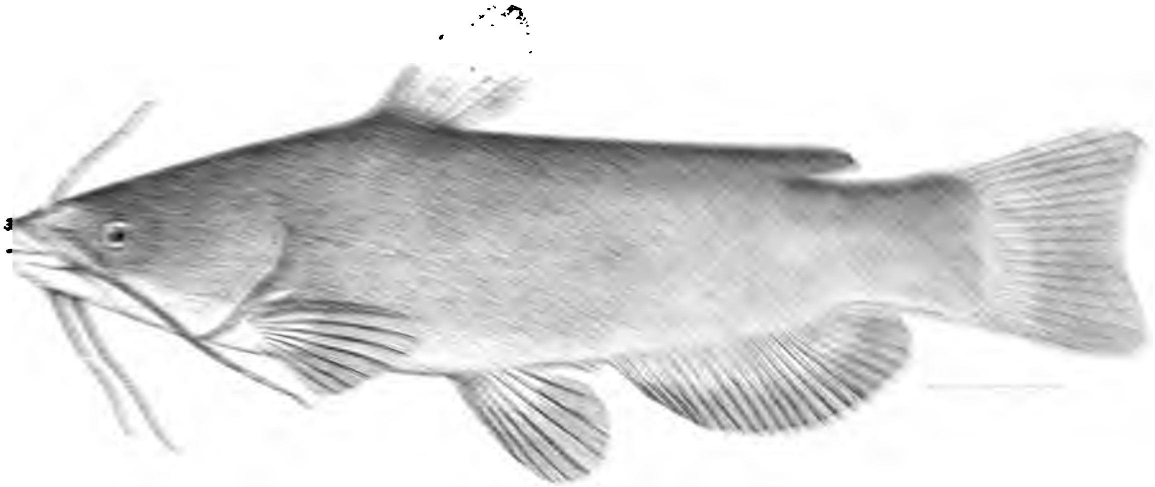
NOTURUS NOCTURNUS Jordan & Gilbert. Type. Sabine River, Belton, Arkansas. H. L. Todd del.



LEPTOPS OLIVARIS (Rafinesque). *Yellow Cat; Mud Cat.* Illinois River. H. L. Todd del.



AMEIURUS MELAS (Rafinesque). ***Bullhead.*** Aux Plaines River, Illinois. H. L. Todd del.



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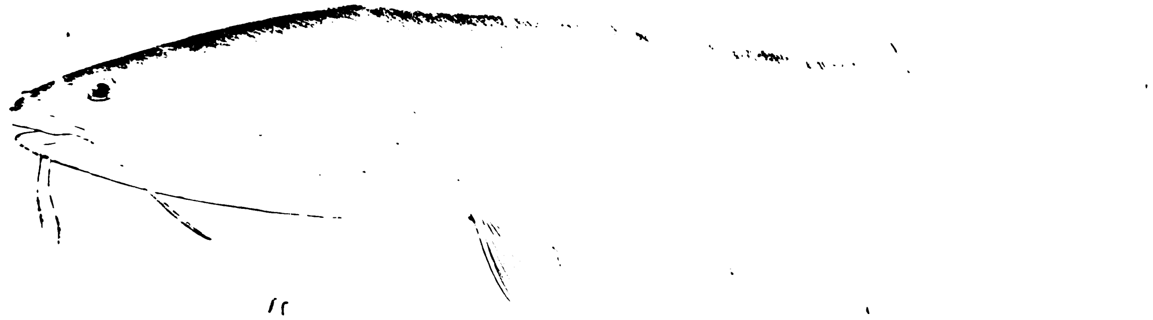
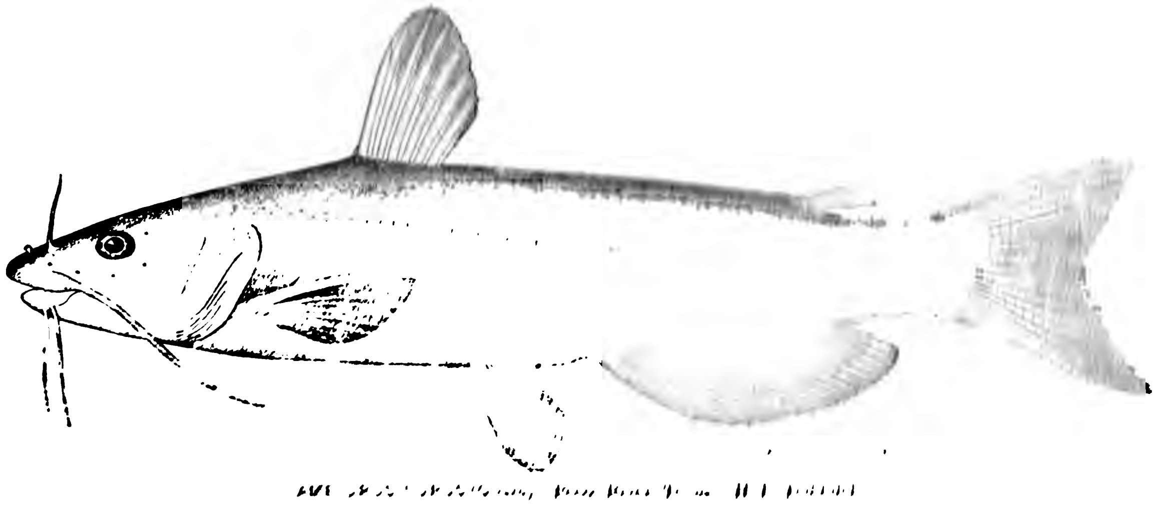


AMEIURUS NATALIS LeSueur. Yellow Cat. Huntsville, Alabama. [illegible]



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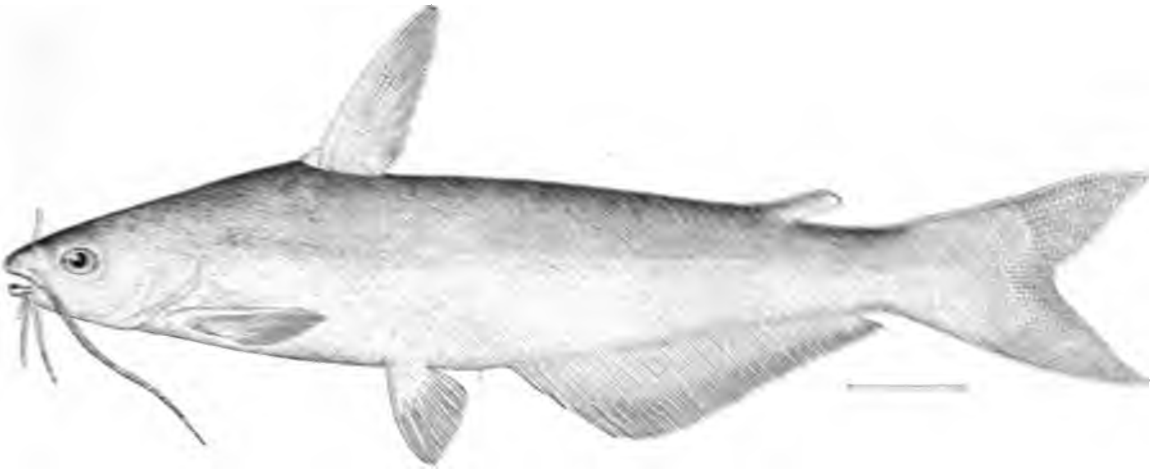
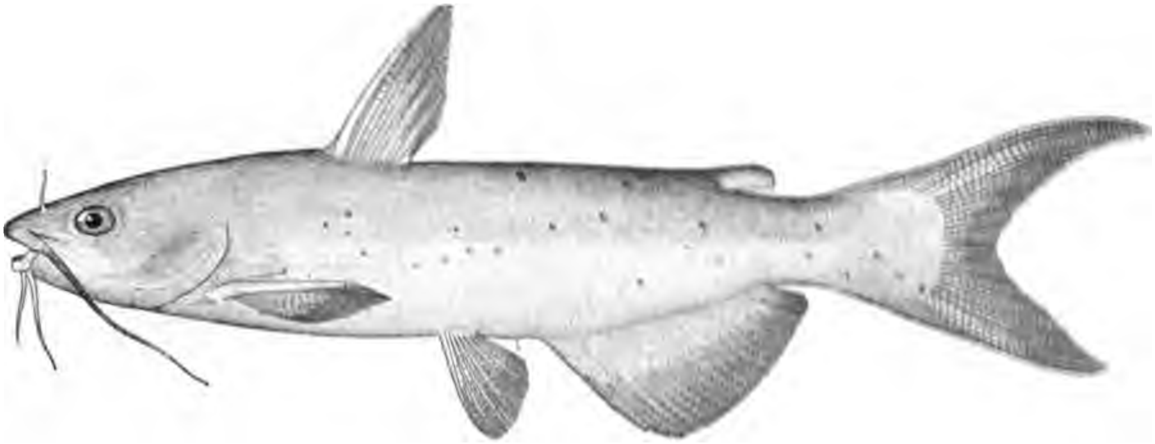
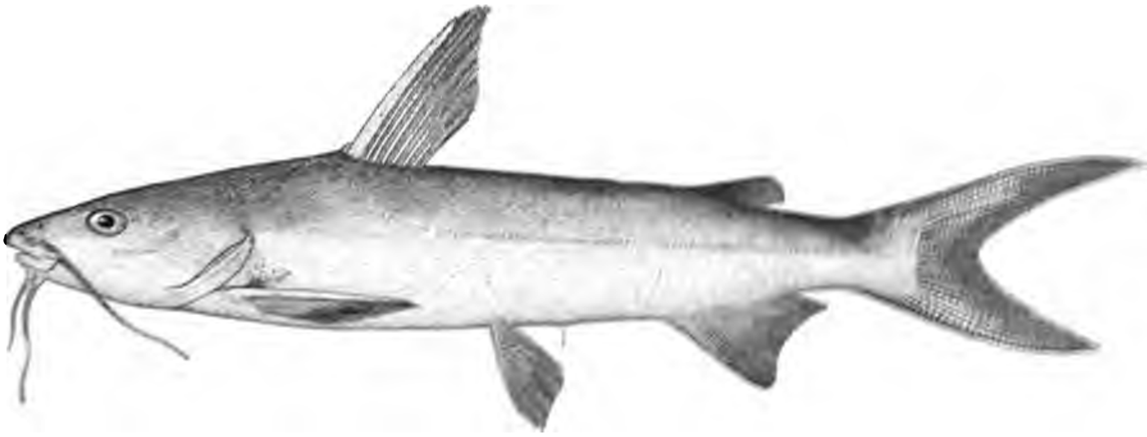


ICTALURUS FURCATUS (Cuvier & Valenciennes) *Chuckle-head Cat; Channel Cat; Blue Cat.* Brownsville, Texas. Miss M. Smith del.

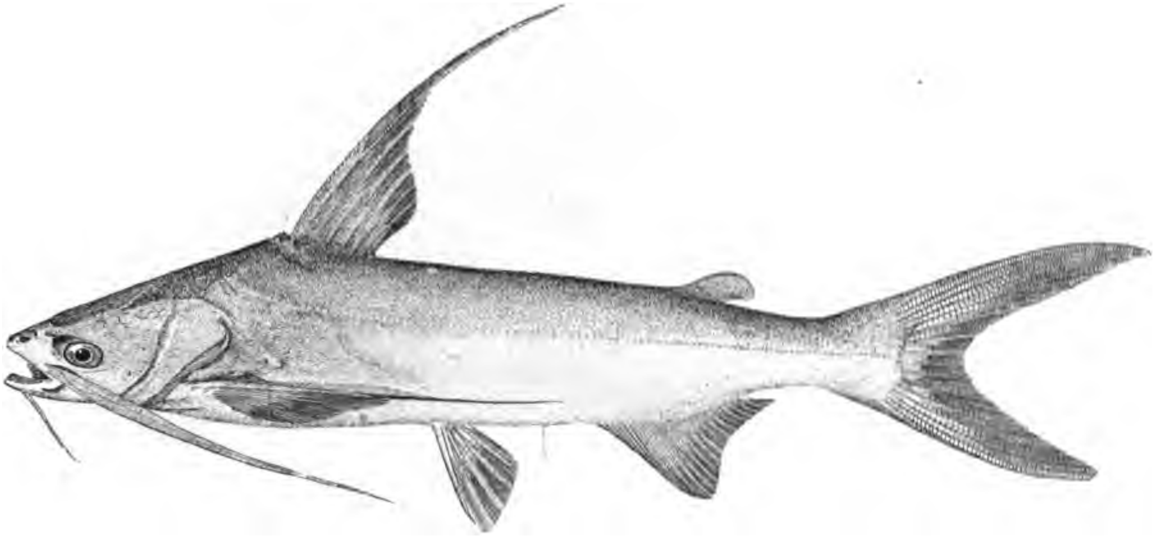


ICTALURUS PUNCTATUS (Rafinesque) *Channel Cat; Eel Cat.* H. L. Todd del.

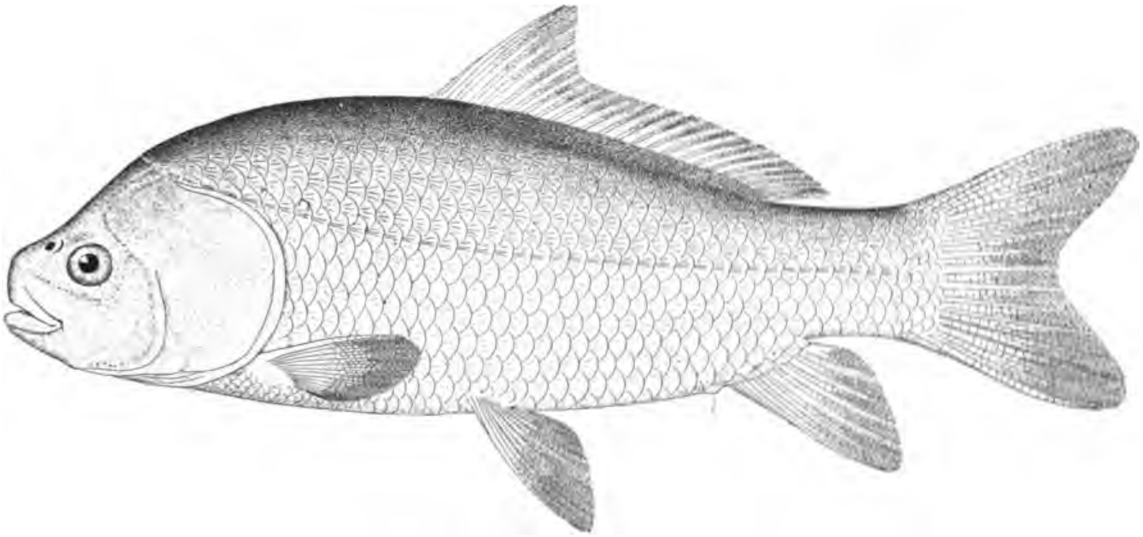


TACHYSURUS FELIS (Linnæus) *Sea Catfish.* H. L. Todd del.

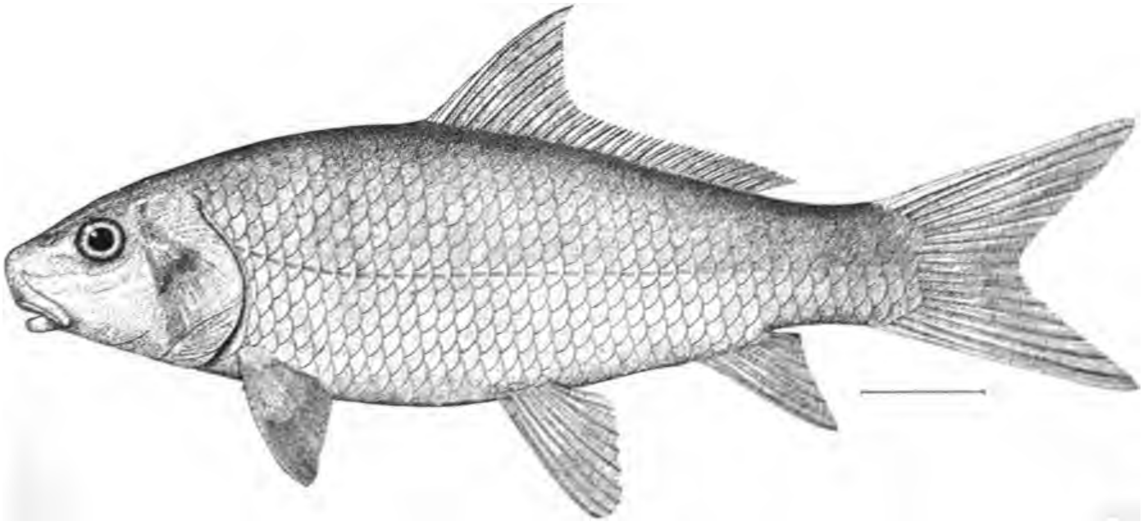
Bull. U S. F. C 1892. Fishes of Texas and the Rio Grande Region. (To face page 126.) PLATE XIV.



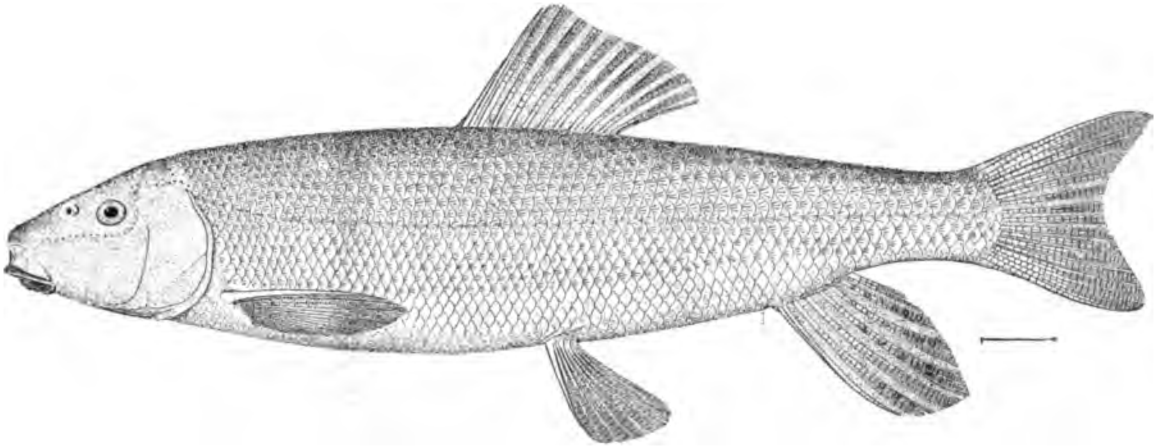
FELICHTHYS MARINUS (Mitchill). *Gaff-topsail.* H. L. Todd del.



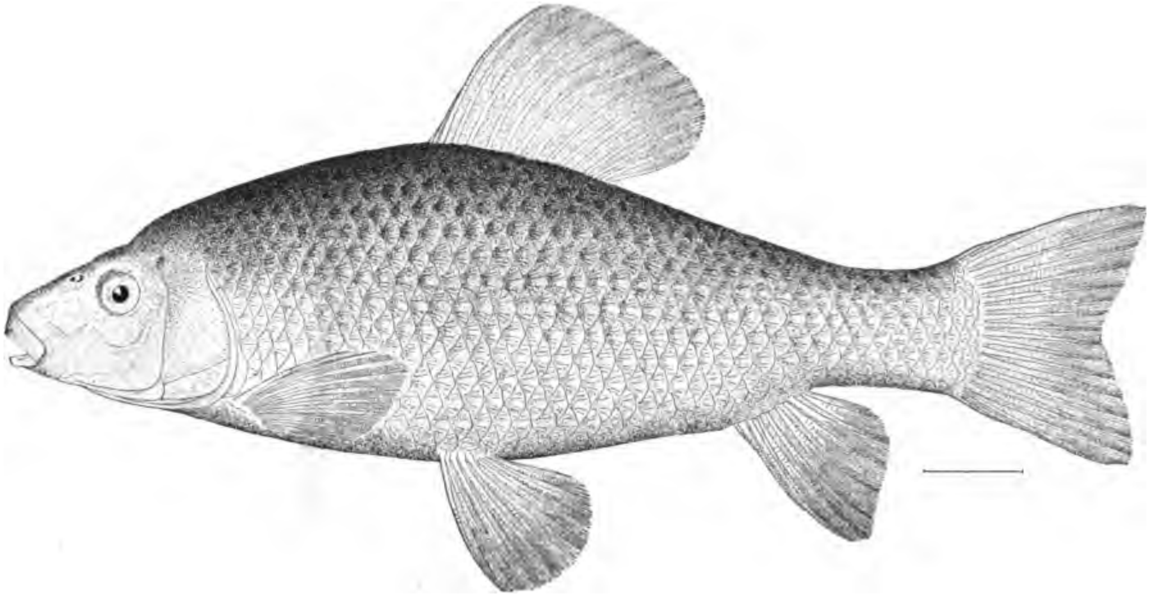
ICTIOBUS CYPRINELLA (Cuvier & Valenciennes). *Common Buffalo-fish.* Missouri River. H. L. Todd del.



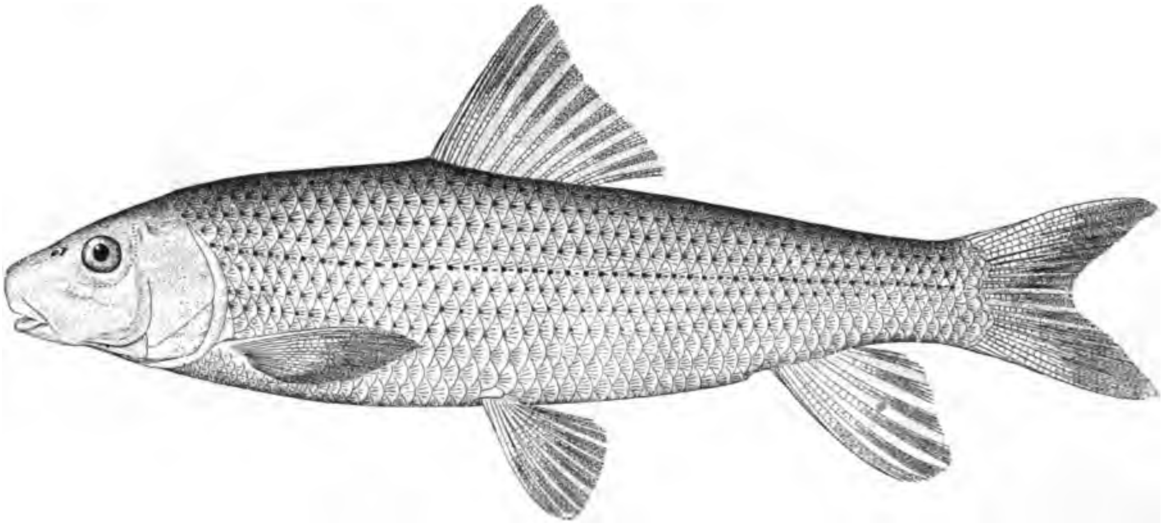
CARPIODES CARPIO (Rafinesque). *Carp Sucker.*



CATOSTOMUS TERES (Mitchill). *Common White Sucker.* Ecorse, Michigan. H. L. Todd del.

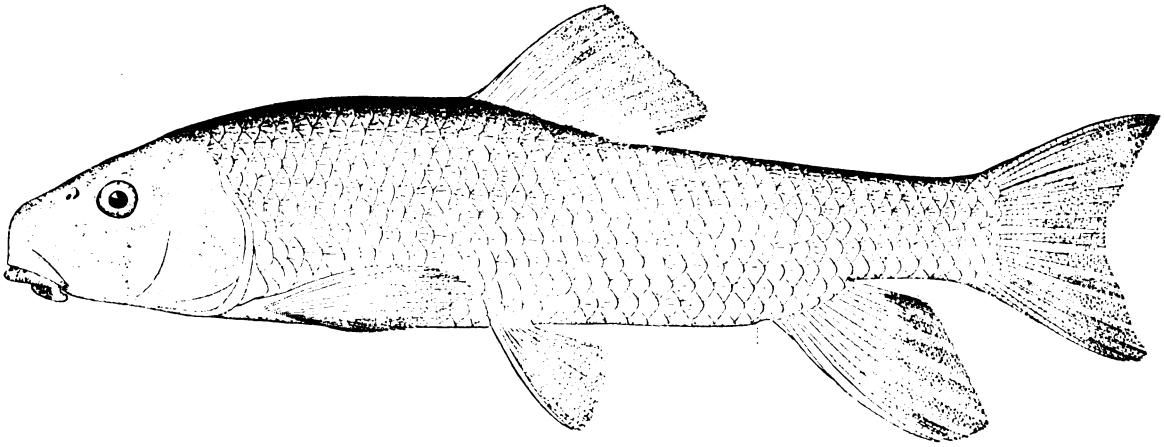


ERIMYZON SUCETTA (Lacépède). *Chub Sucker; Creek Sucker.* Ogechee Ponds, Savannah, Georgia. Miss M. Smith del.

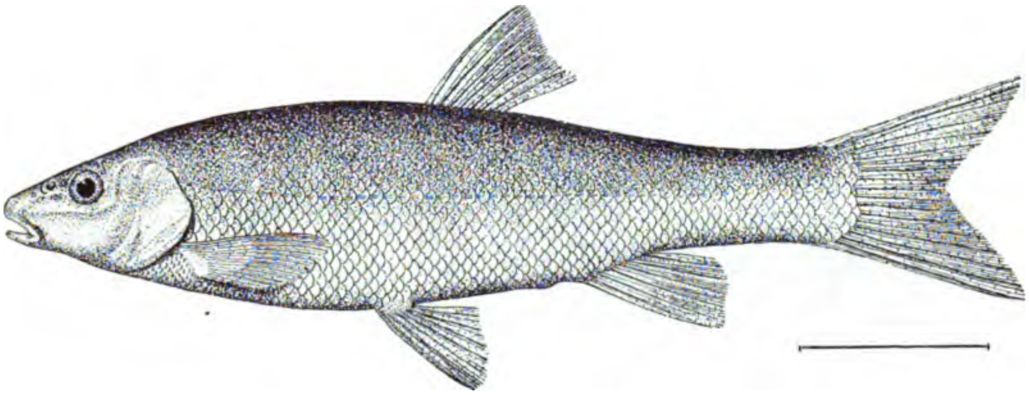


MINYTREMA MELANOPS (Rafinesque). *Striped Sucker.* H. L. Todd del.

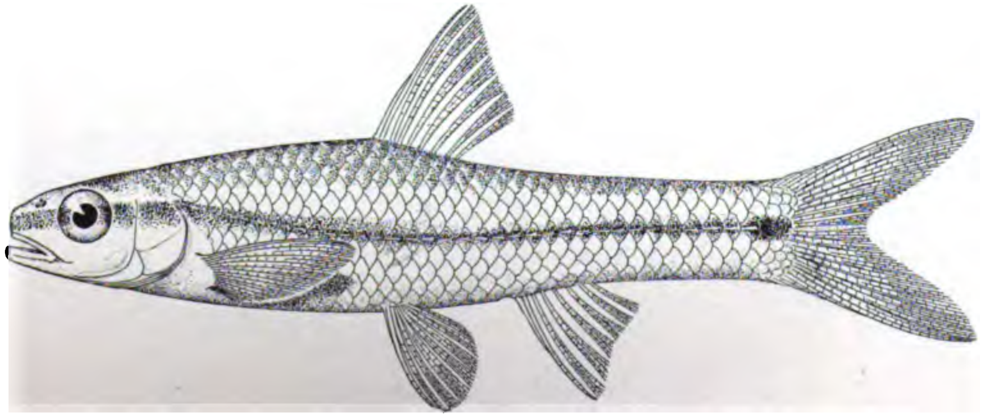
PLATE XVI.



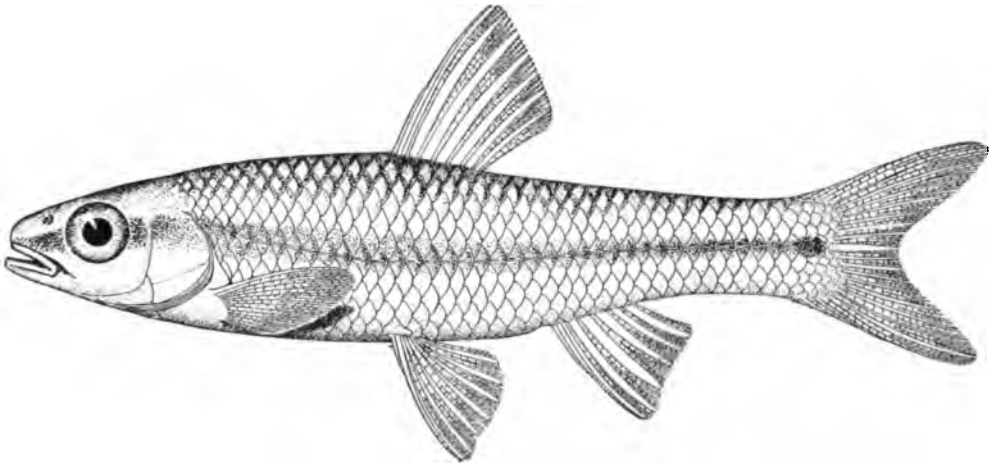
MOXOSTOMA CONGESTUM (Baird & Girard). Lampasas River, Belton, Texas. H. L. Todd del.



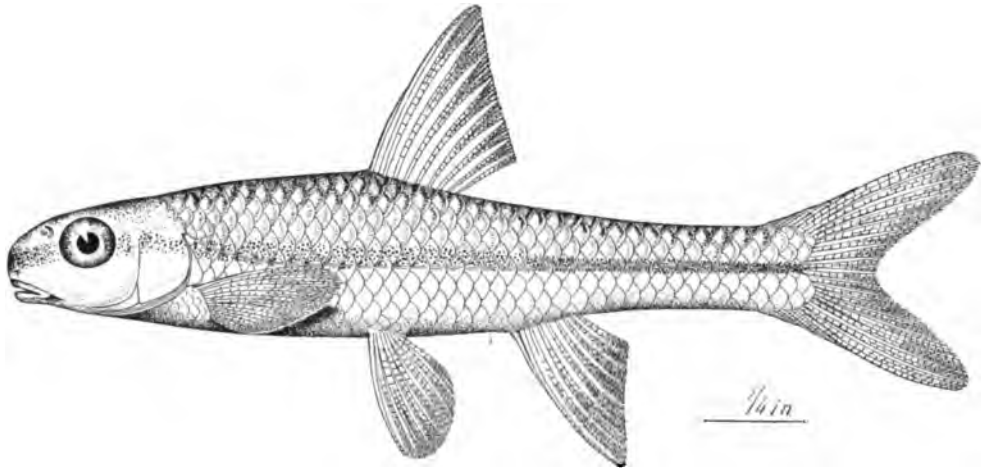
CAMPOSTOMA ANOMALUM (Rafinesque). *Stone-roller*. White River, Eureka Springs, Arkansas. Wm. Haines del.



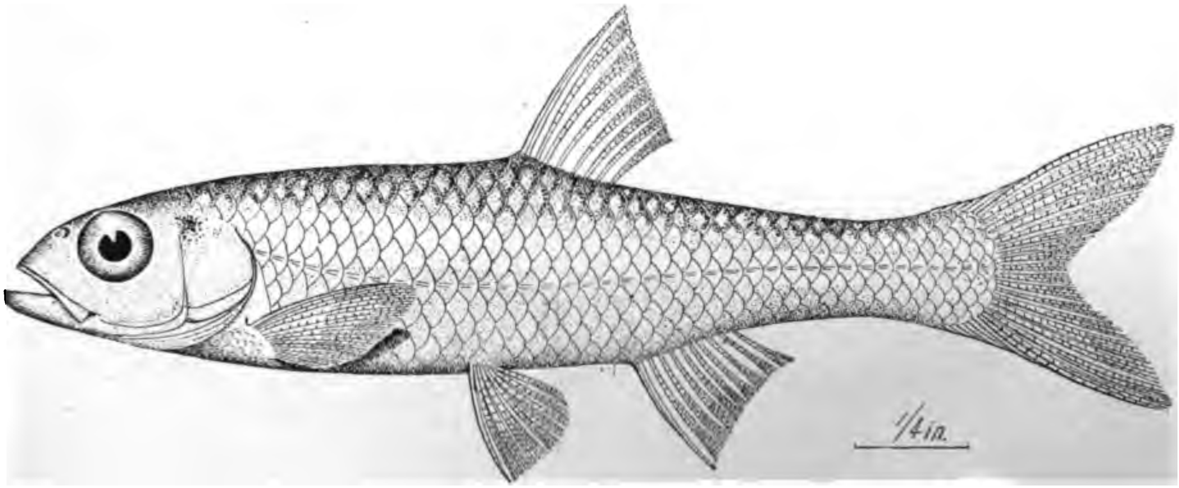
NOTROPIS CAYUGA ATROCAUDALIS Evermann. Type. Neches River, Palestine, Texas. A. H. Baldwin del.



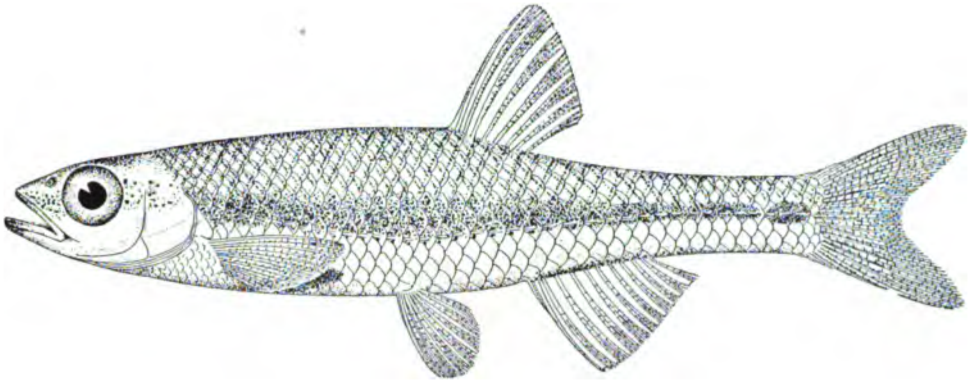
NOTROPIS NUX Evermann. Type. Neches River, Palestine, Texas. A. H. Baldwin del.



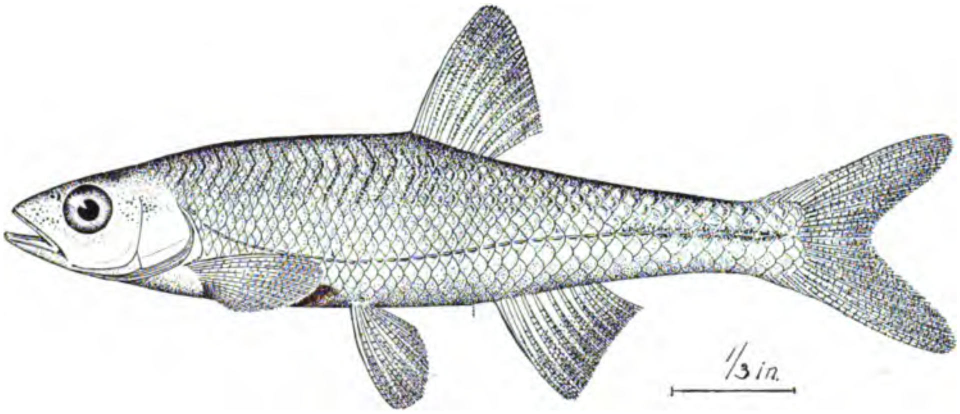
NOTROPIS NOCOMIS Evermann. Type. Trinity River, Magnolia Point, Texas. A. H. Baldwin del.



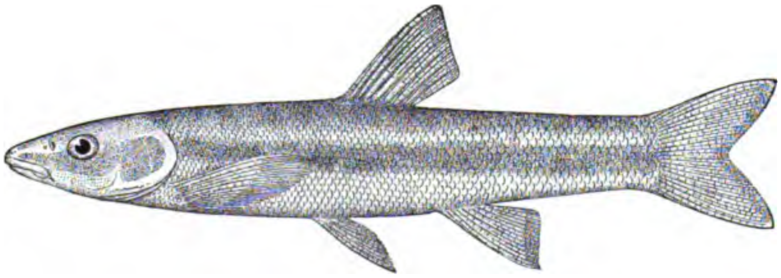
NOTROPIS SWAINI Jordan & Gilbert. San Marcos River, San Marcos, Texas. A. H. Baldwin del.



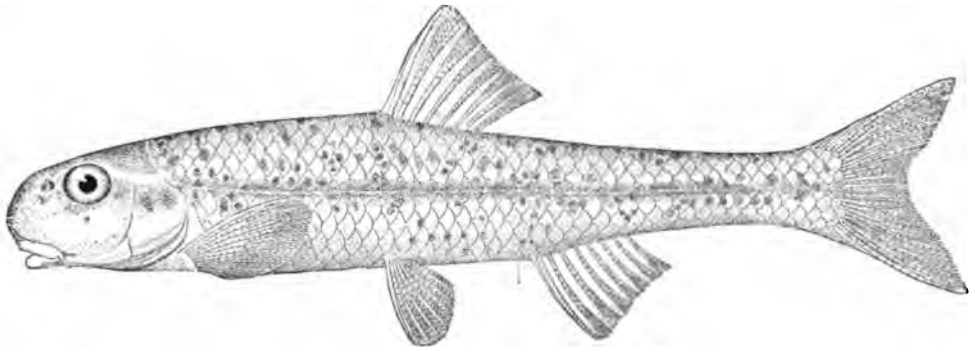
NOTROPIS FUMEUS Evermann. Type. Hunter Creek, Houston, Texas. A. H. Baldwin del.



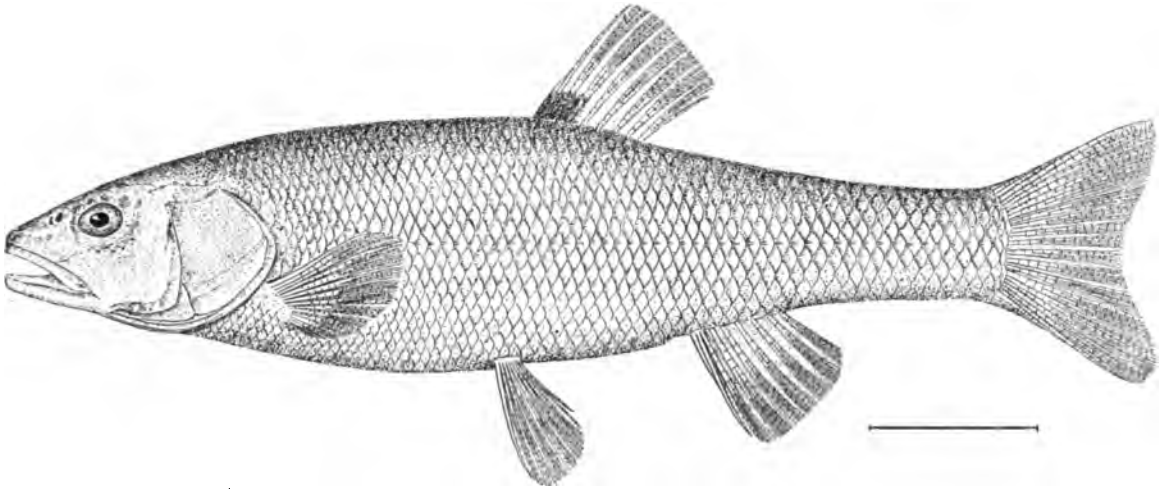
NOTROPIS NOTEMIGONOIDES Evermann. Type. Neches River, Palestine, Texas. A. H. Baldwin del.



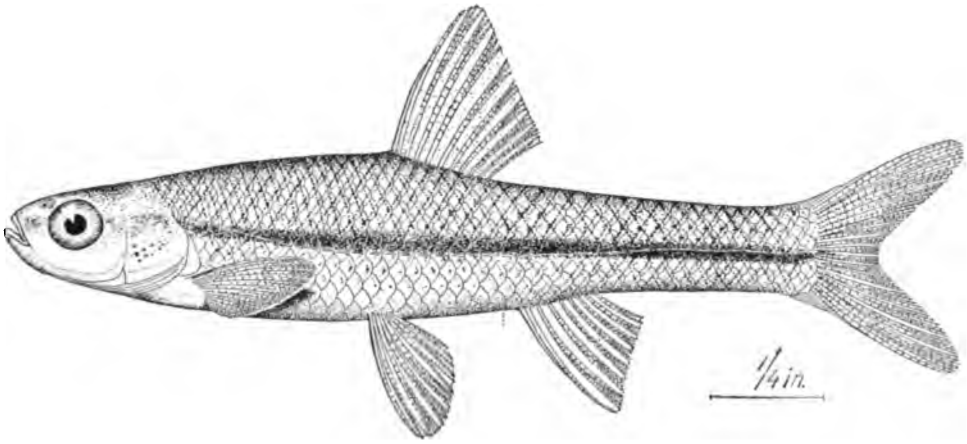
RHINICHTHYS DULCIS (Girard). *Dace.* S. F. Denton del.



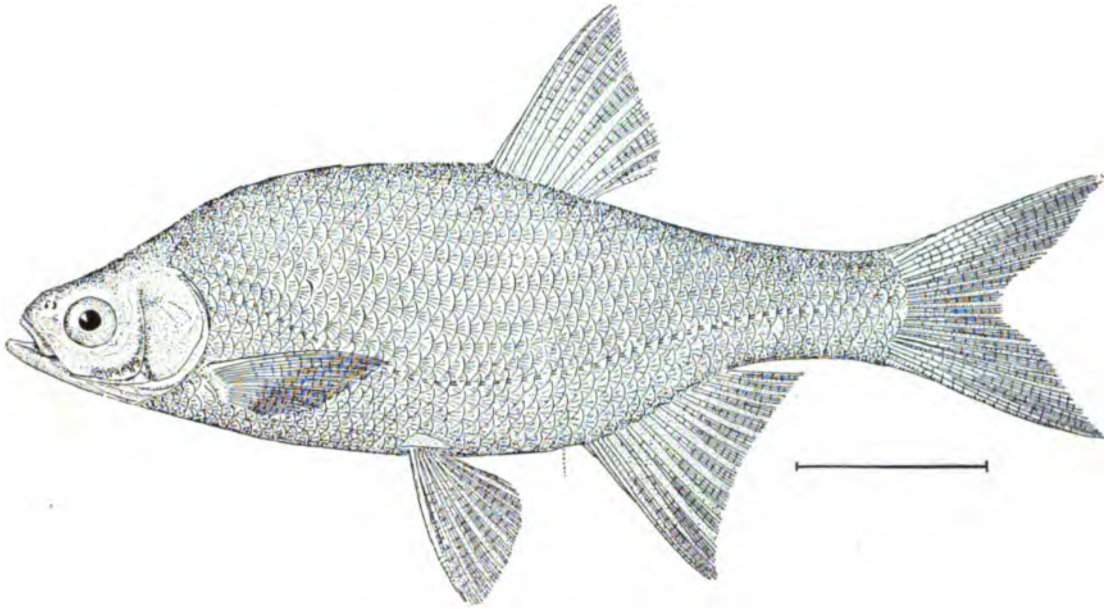
HYBOPSIS ÆSTIVALIS MARCONIS Jordan & Gilbert. About twice natural size. San Marcos River, San Marcos, Texas.
A. H. Baldwin del.



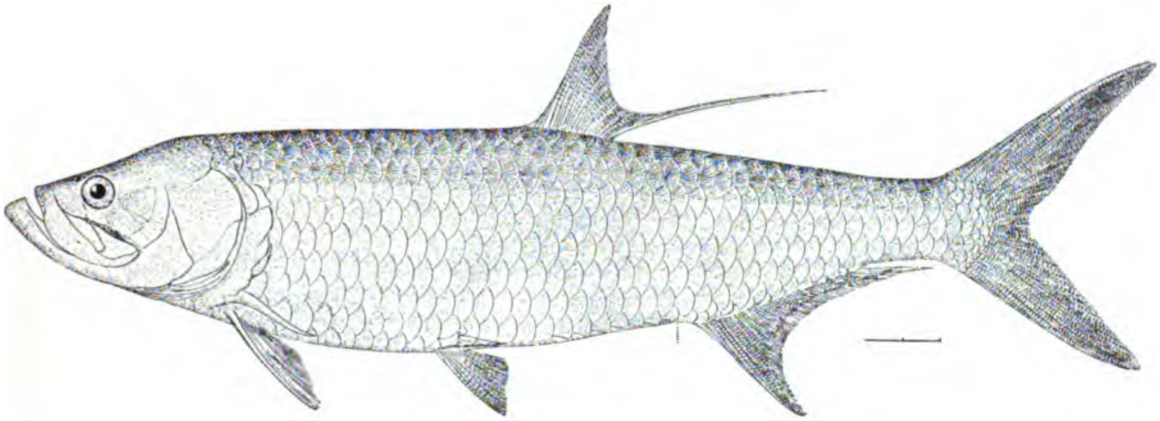
SEMOTILUS ATROMACULATUS (Mitchill). *Horned Dace; Creek Chub.* Aux Plaines River, Illinois. H. L. Todd del.



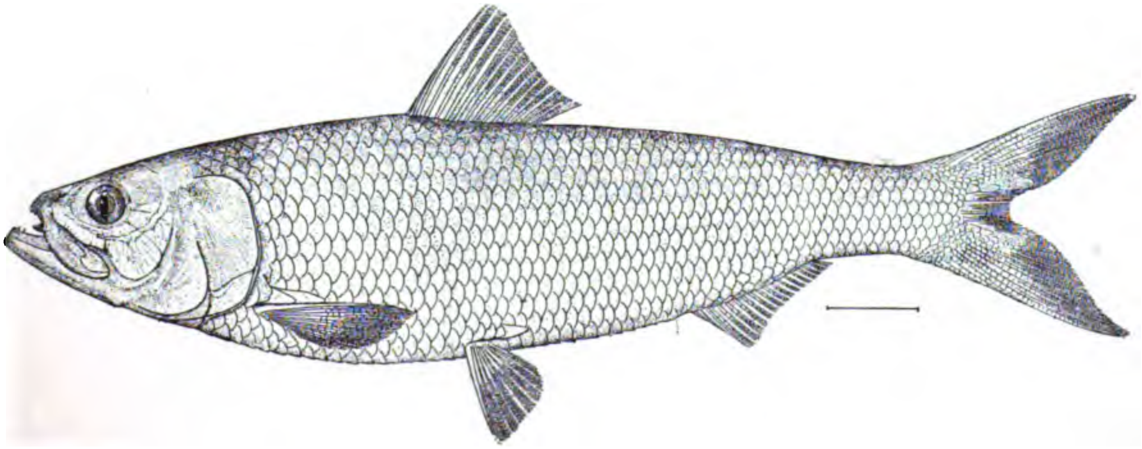
OPSOPŒODUS OSCULA Evermann. Type. Buffalo Bayou, Houston, Texas. A. H. Baldwin del.



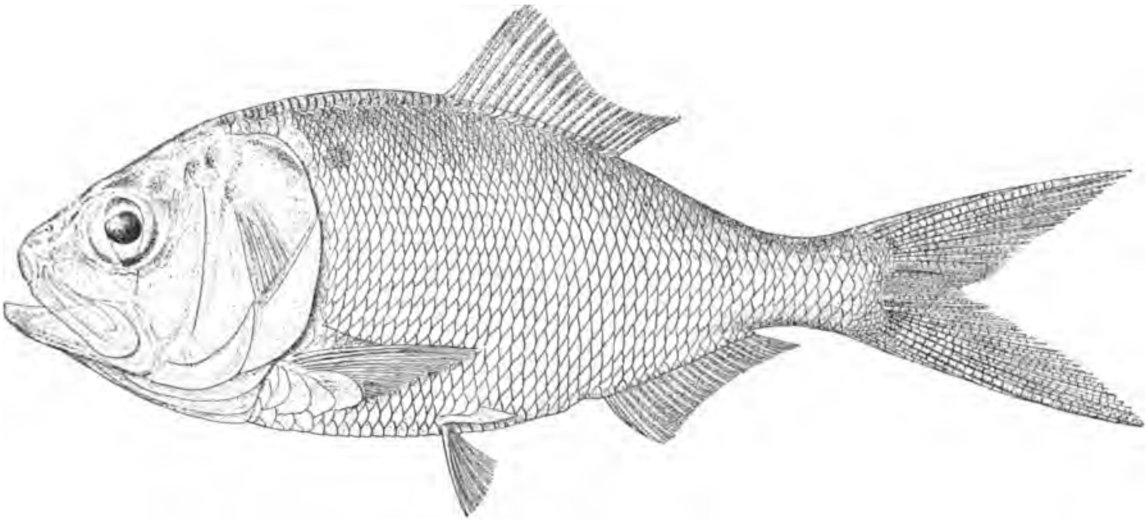
NOTEMIGONUS CHRYSOLEUCUS (Mitchill). *Bream.* Hackensack River, New Jersey. H. L. Todd del.



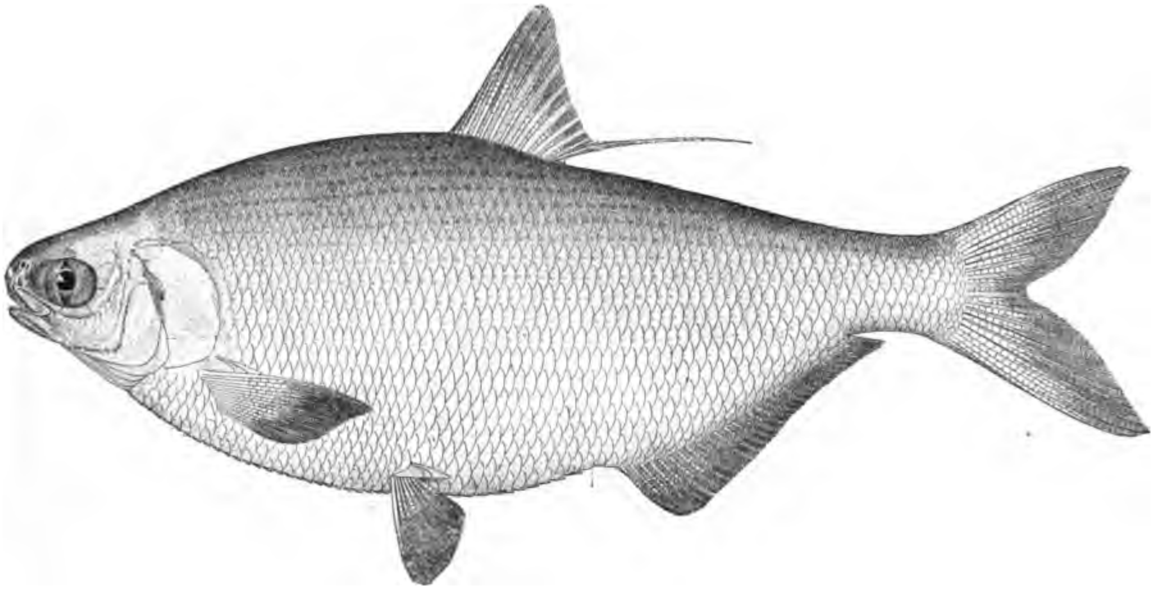
MEGALOPS ATLANTICUS (Cuvier & Valenciennes). *Tarpon; Tarpum.* H. L. Todd del.



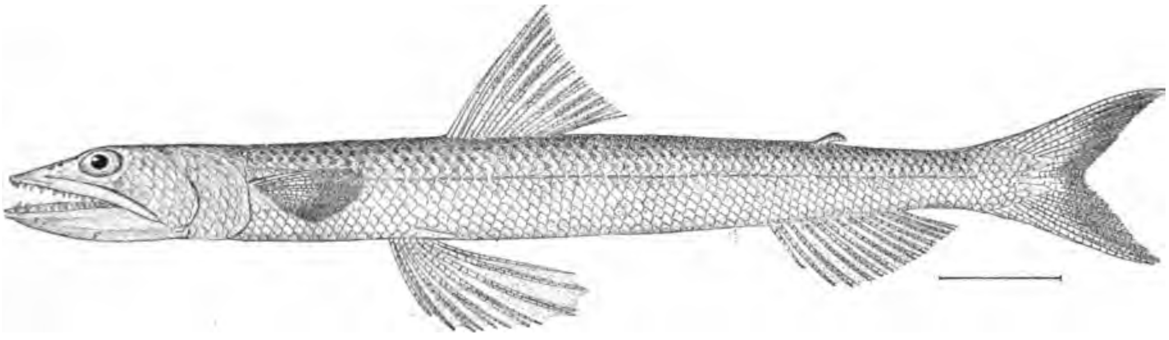
CLUPEA CHRYSOCHLORIS (Rafinesque). *Skipjack.* Pensacola, Florida. H. L. Todd del.



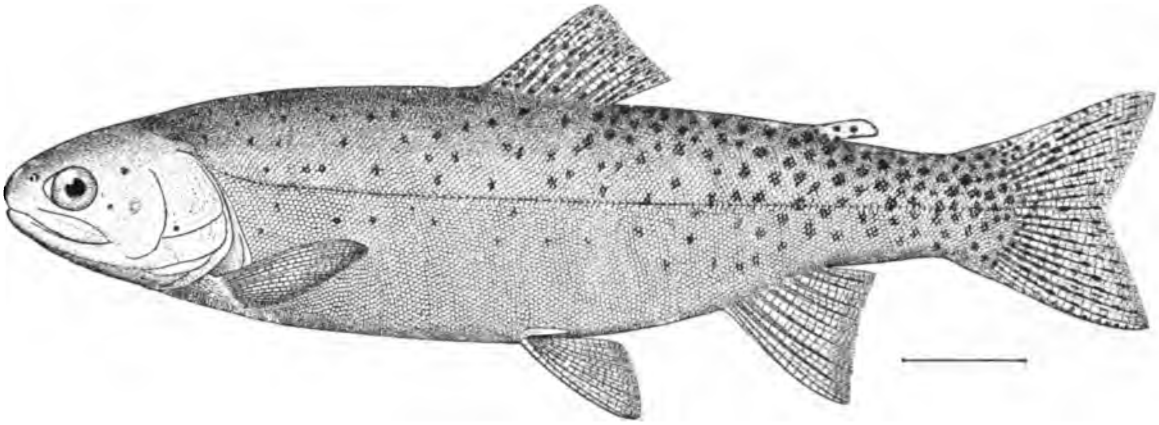
BREVOORTIA TYRANNUS PATRONUS Goode. *Gulf Menhaden.* Brazos Santiago, Texas. H. L. Todd del.



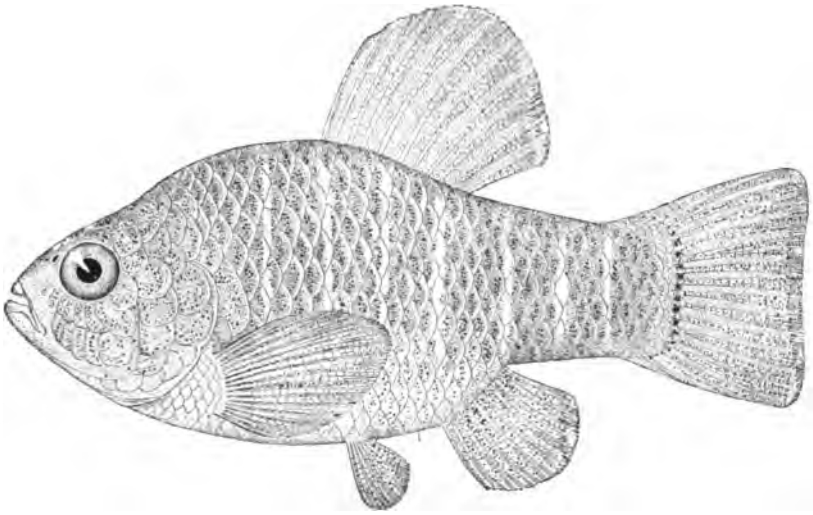
DOROSOMA CEPEDIANUM (Le Sueur). *Gizzard Shad; Hickory Shad.* H. L. Todd del.



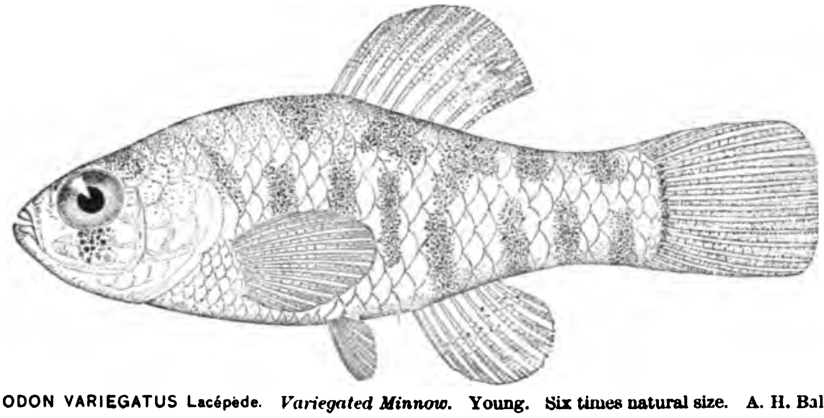
SYNODUS FŒTENS (Linnæus). *Lizard-fish.* Charleston, South Carolina. H. L. Todd del.



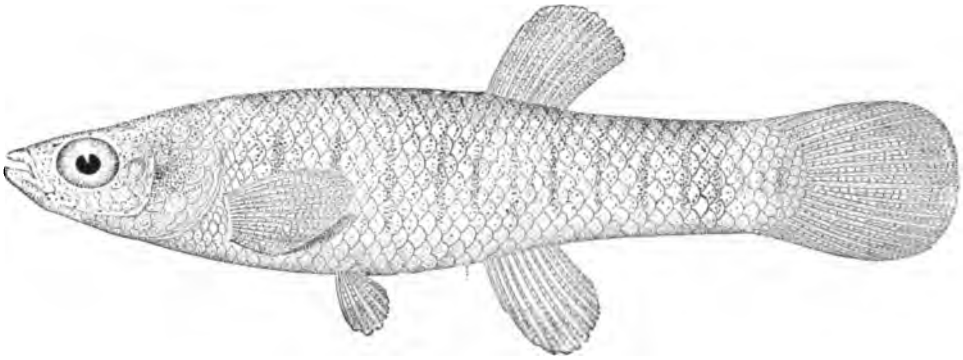
SALMO MYKISS SPILURUS Cope. *Rio Grande Trout.* Rio Grande Del Norte, Colorado. S. F. Denton del.



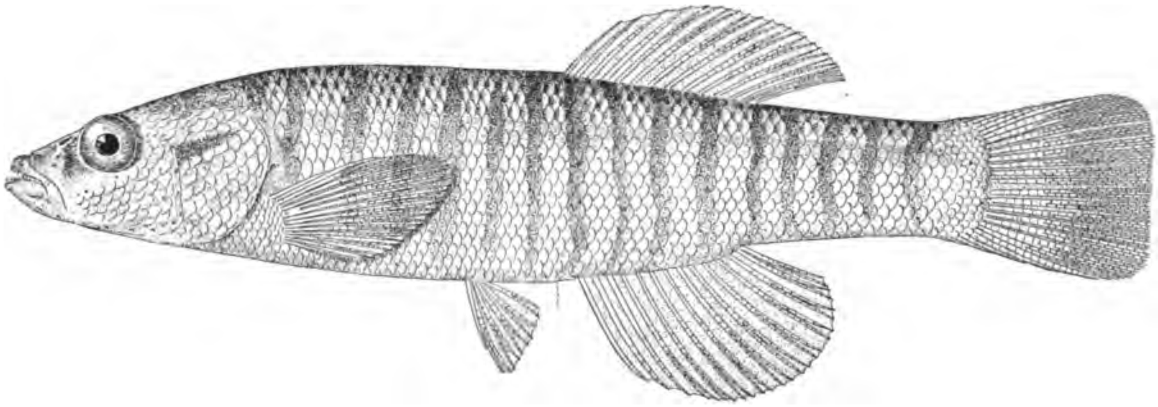
CYPRINODON VARIEGATUS Lacépède. *Variegated Minnow.* Male. Twice natural size. A. H. Baldwin del.



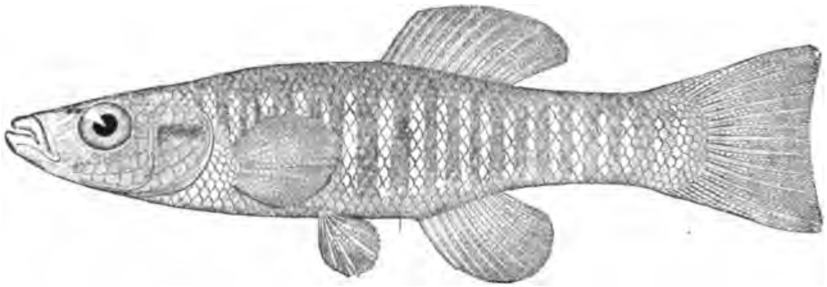
CYPRINODON VARIEGATUS Lacépède. *Variegated Minnow.* Young. Six times natural size. A. H. Baldwin del.



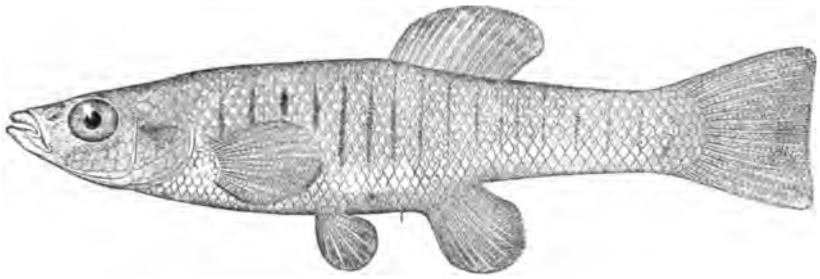
FUNDULUS PALLIDUS Evermann. **Type.** About three times natural size. **Galveston Bay, Texas.** A. H. Baldwin del.



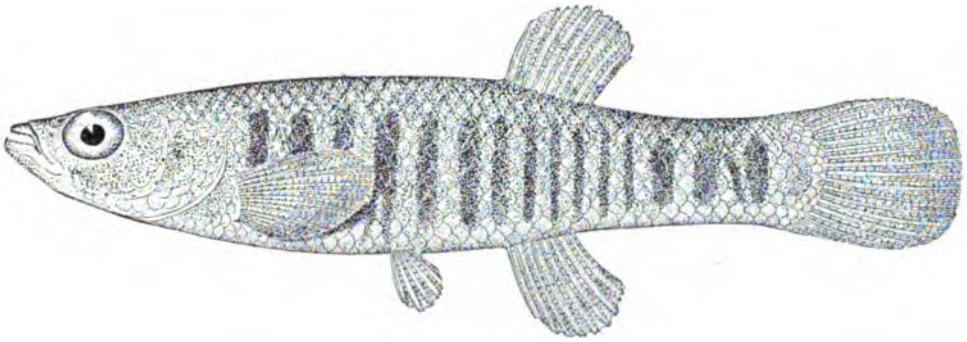
FUNDULUS ZEBRINUS Jordan & Gilbert. **Ellis, Kansas.** H. L. Todd del.



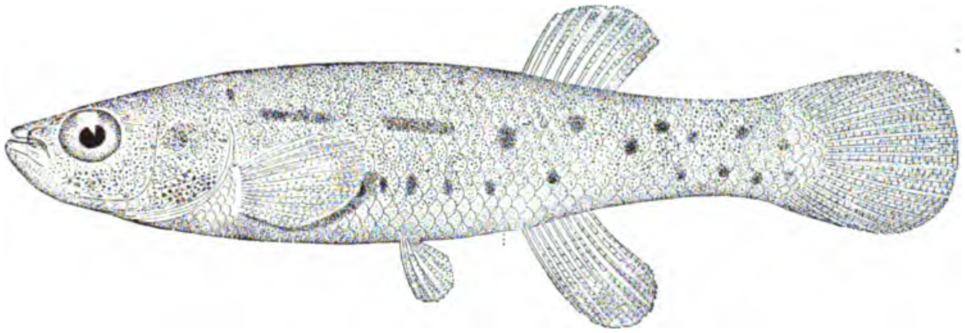
FUNDULUS DIAPHANUS Le Sueur. ***Spring Minnow.*** **Male.** One and one-fifth times natural size. A. H. Baldwin del.



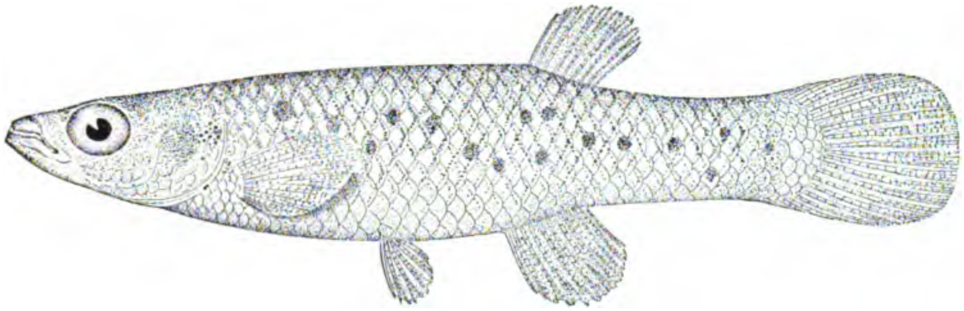
FUNDULUS DIAPHANUS Le Sueur. ***Spring Minnow.*** **Female.** One and one-fifth times natural size. A. H. Baldwin del.



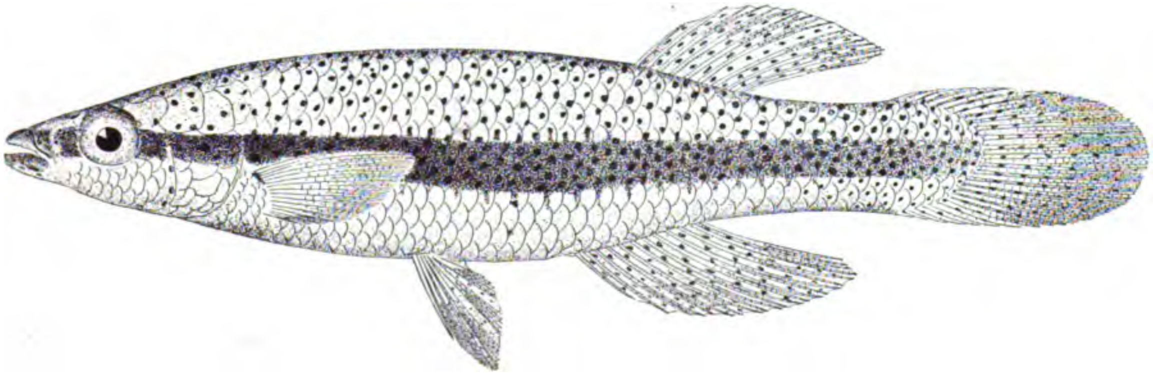
ZYGONECTES FUNDULOIDES Evermann. About three and a half times natural size. Dickinson Bayou, Dickinson, Texas.
A. H. Baldwin del.



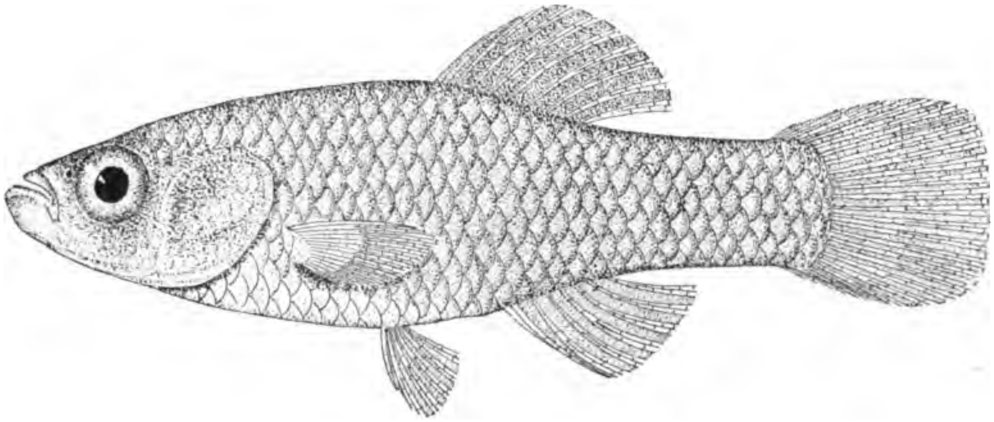
ZYGONECTES PULVEREUS Evermann. About three times natural size. Dickinson Bayou, Dickinson, Texas. A. H. Baldwin del.



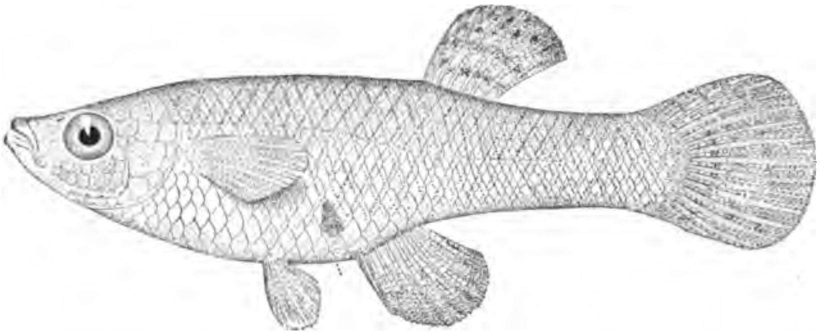
ZYGONECTES JENKINSI Evermann. About three times natural size. Galveston Bay, Galveston, Texas. A. H. Baldwin del.



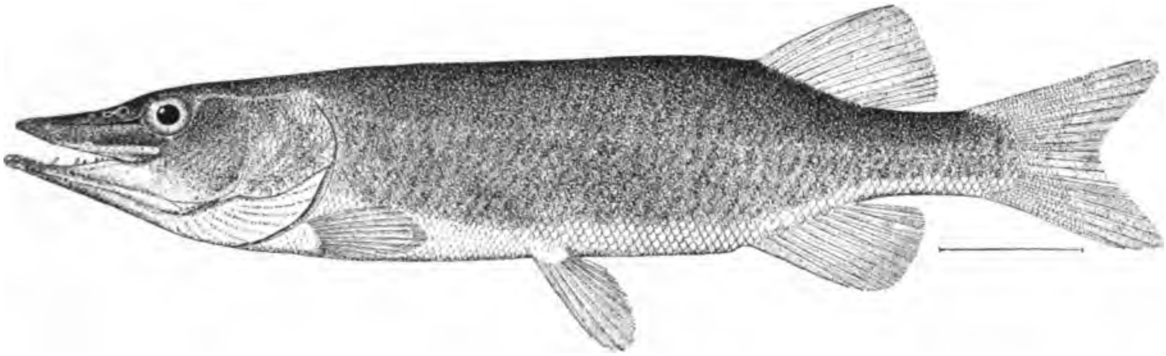
ZYGONECTES NOTATUS (Rafinesque). *Top Minnow.* White River, Eureka Springs, Arkansas. H. L. Todd del.



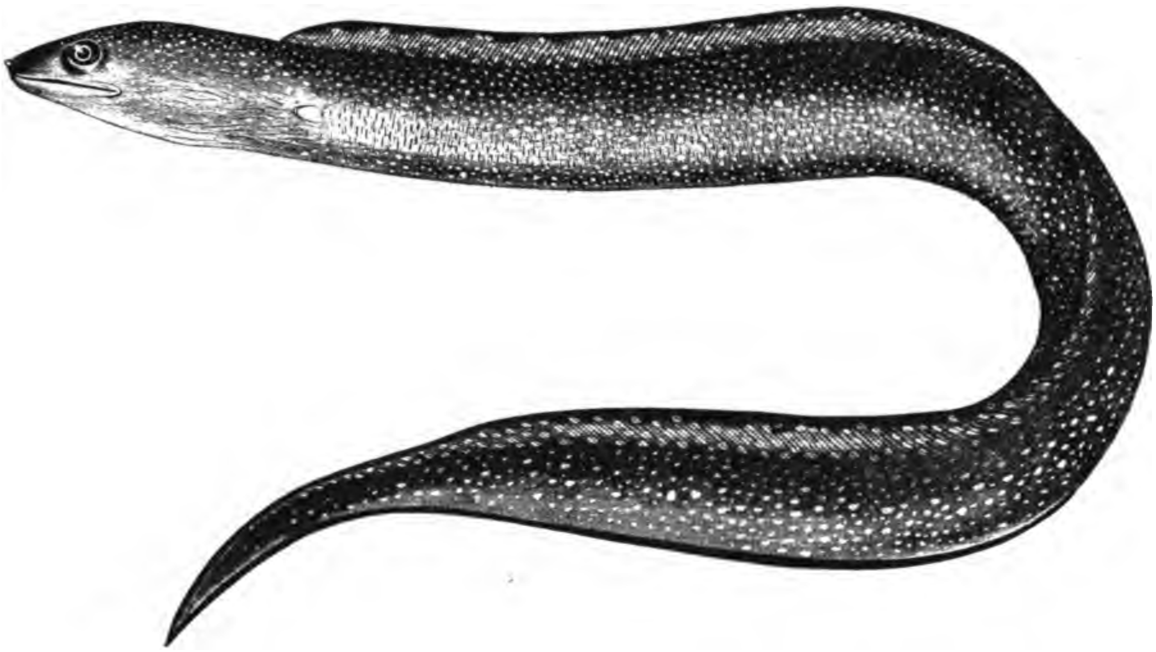
LUCANIA PARVA (Baird & Girard). Wm. Haines del.



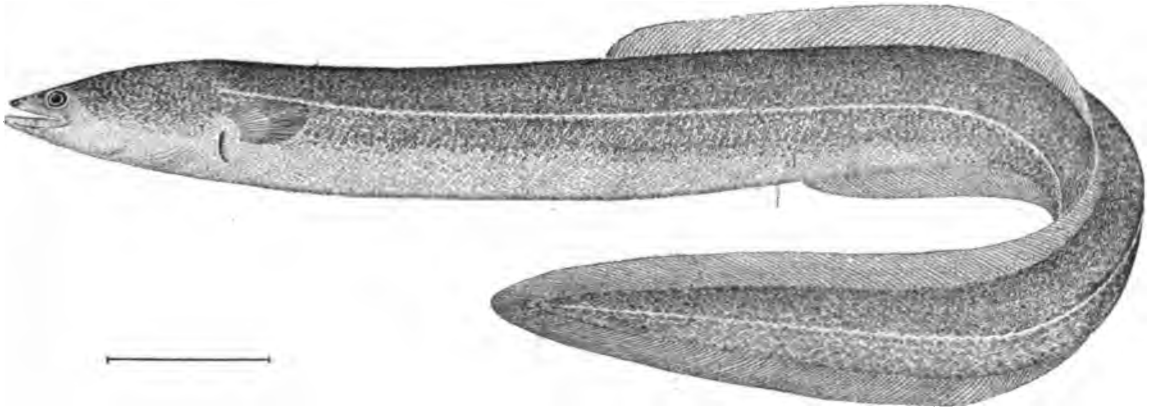
GAMBUSIA AFFINIS (Baird & Girard). Female. Two and one half times natural size. A. H. Baldwin del.



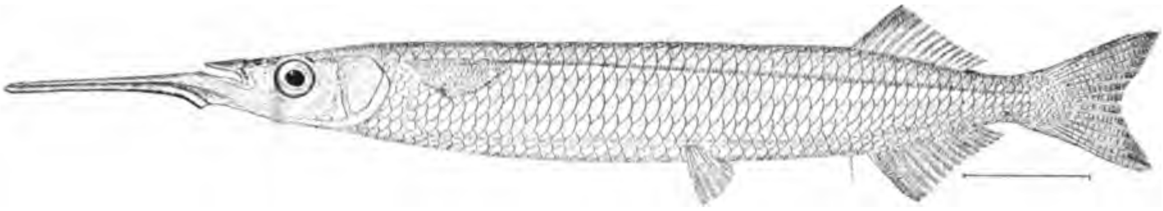
LUCIUS VERMICULATUS (Le Sueur). *Little Pickerel.* New Orleans, Louisiana. Wm. Haines del.



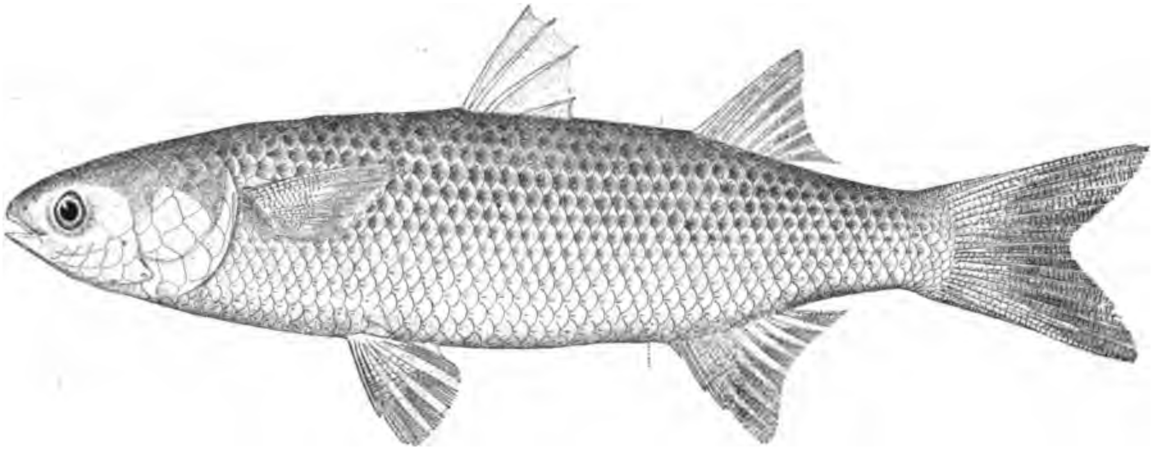
GYMNOTHORAX OCELLATUS NIGROMARGINATUS (Girard). From type. St. Joseph Island, Texas.



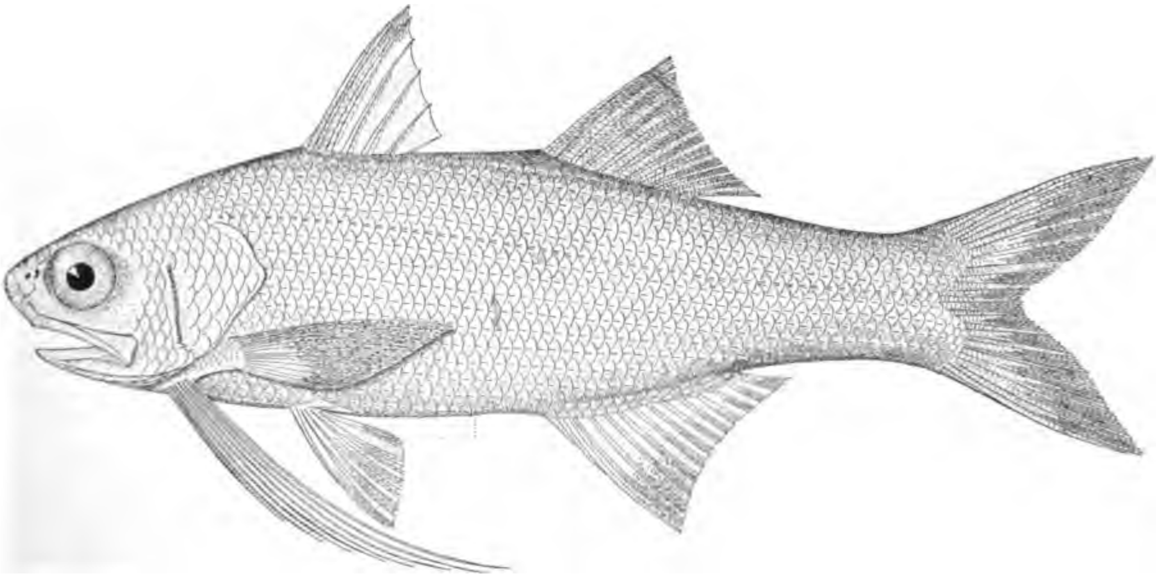
ANGUILLA CHRYSYPA Rafinesque. *Common Eel.* Holyoke, Massachusetts. H. L. Todd del.



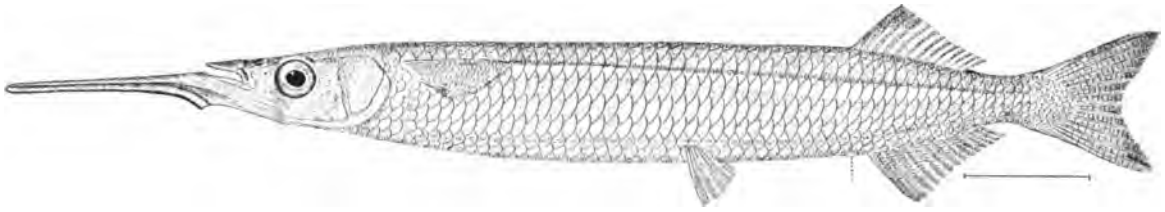
HEMIRHAMPHUS UNIFASCIATUS Ranzani. *Half-beak.* Chesapeake Bay. H. L. Todd del.



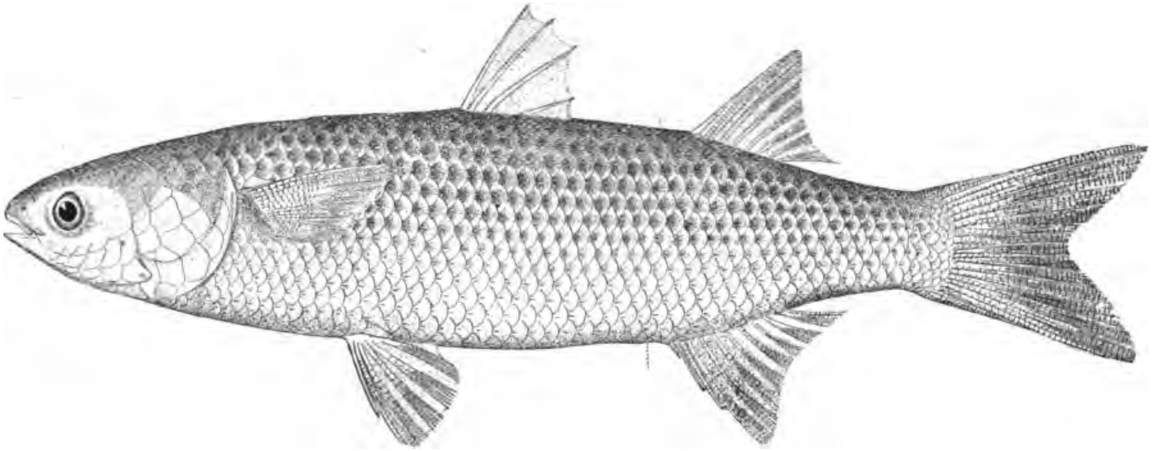
MUGIL CEPHALUS Linnæus. *Common Mullet; Striped Mullet.* H. L. Todd del.



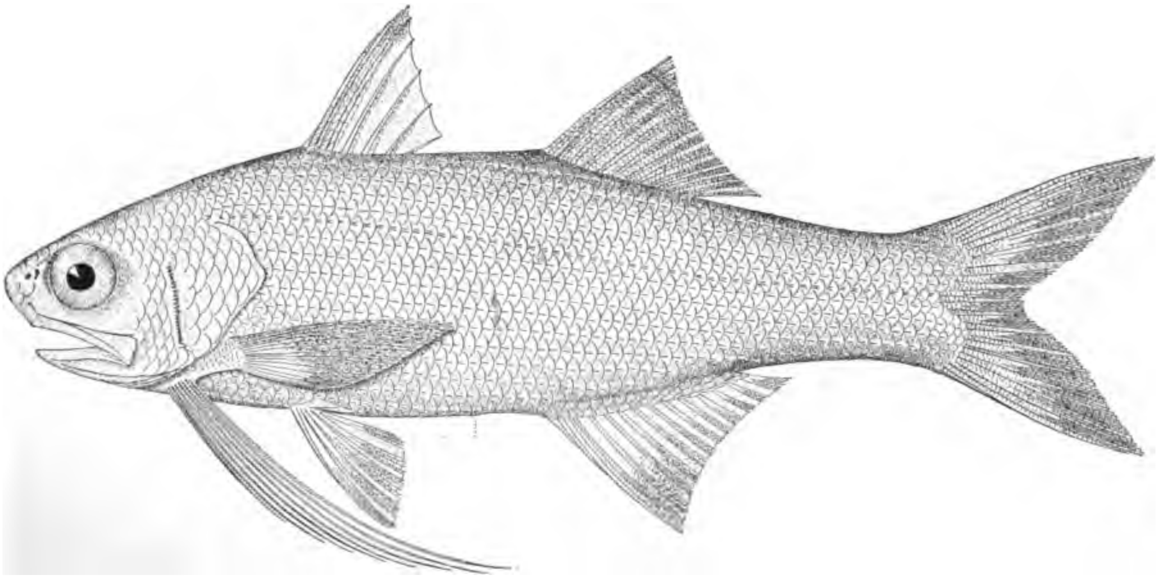
POLYNEMUS OCTONEMUS Girard. *Threadfin.* H. L. Todd del.



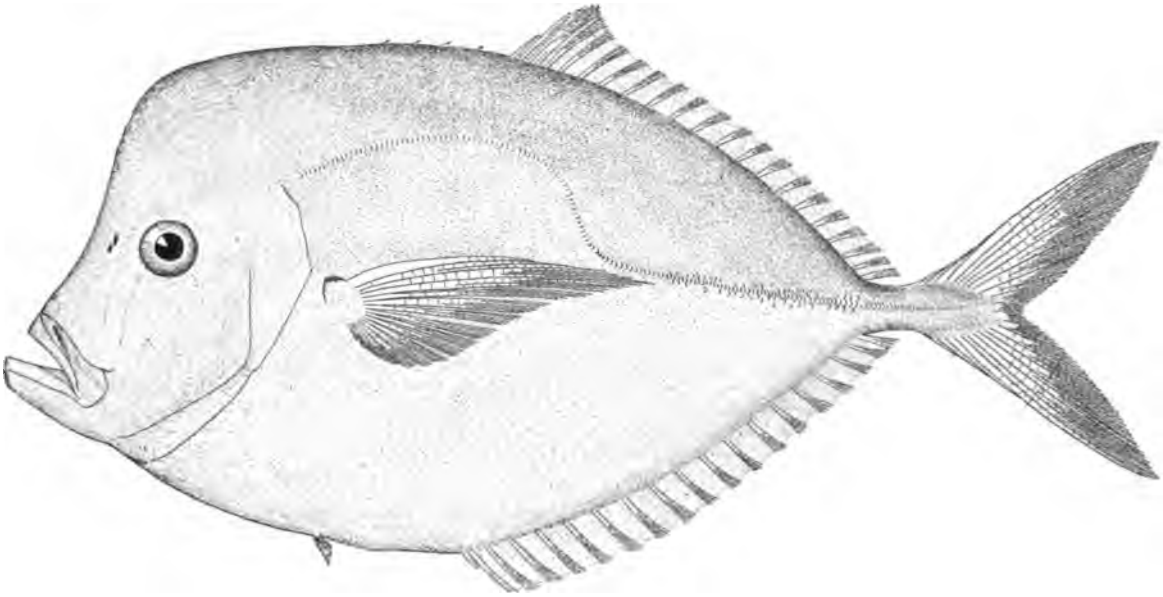
HEMIRHAMPHUS UNIFASCIATUS Ranzani. *Half-beak.* Chesapeake Bay. H. L. Todd del.



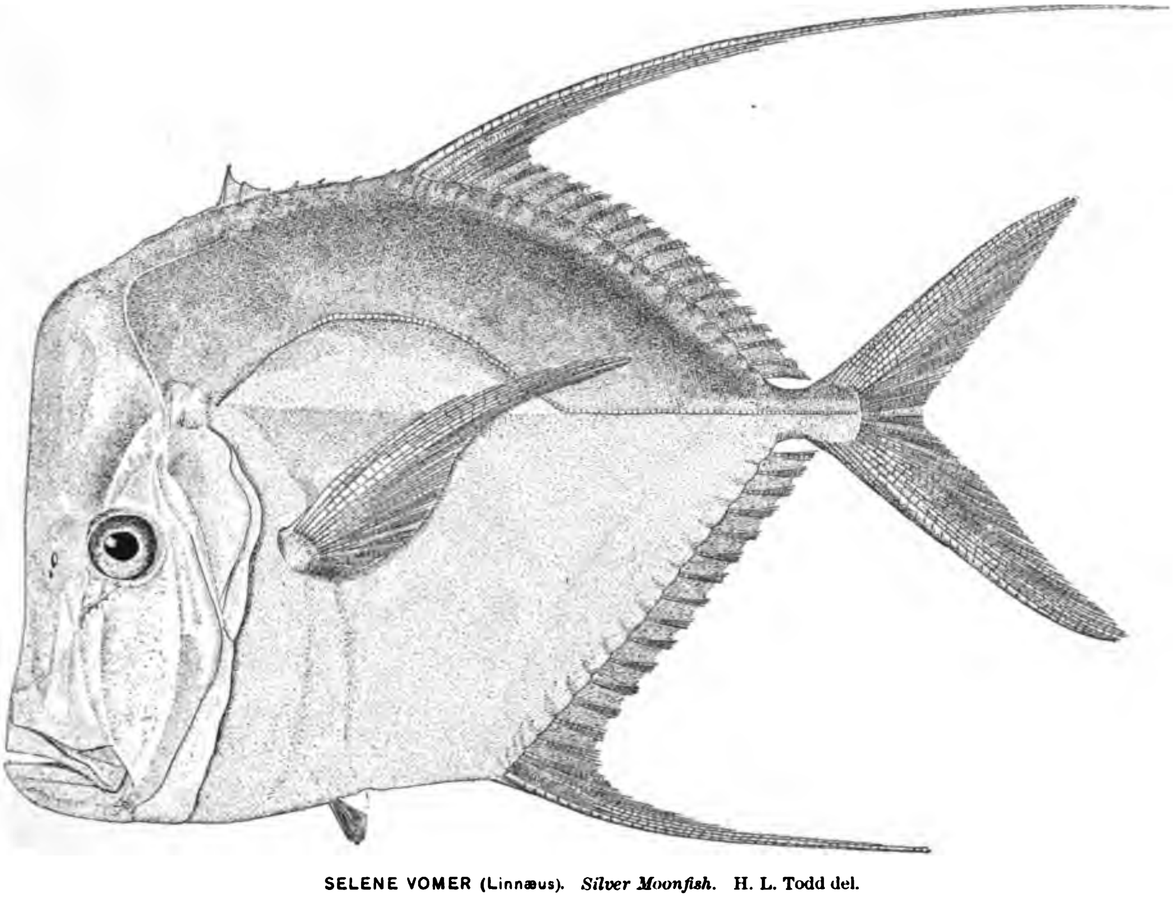
MUGIL CEPHALUS Linnæus. *Common Mullet; Striped Mullet.* H. L. Todd del.



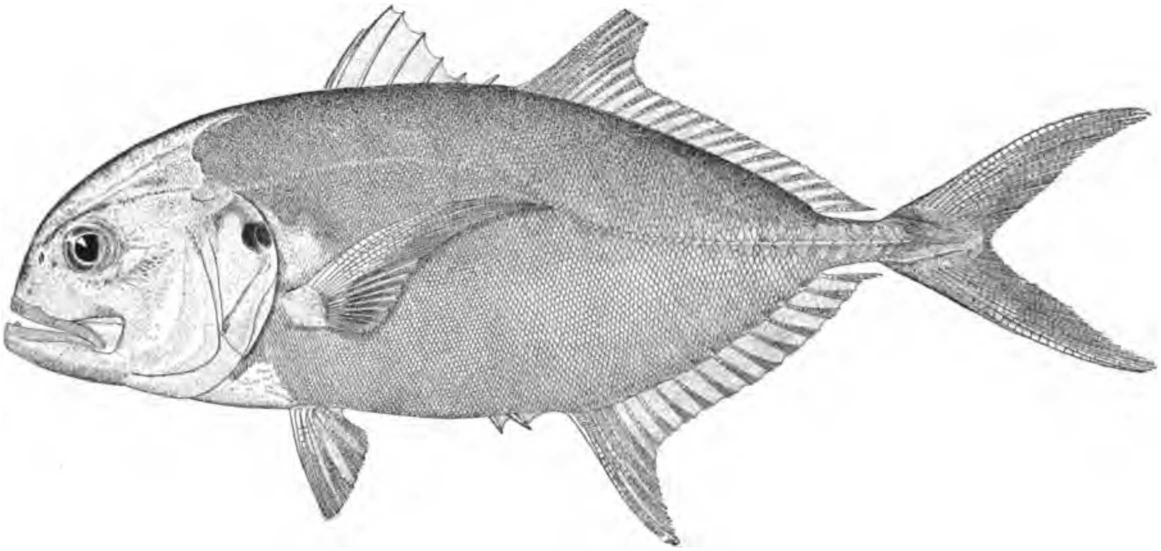
POLYNEMUS OCTONEMUS Girard. *Threadfin.* H. L. Todd del.



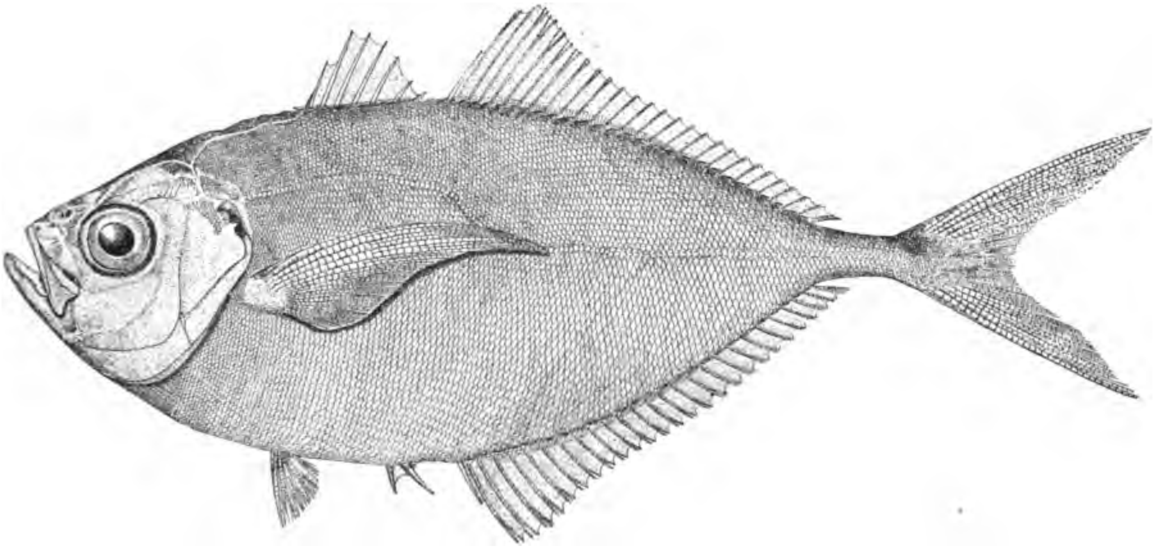
VOMER SETIPINNIS (Mitchill). *Blunt-nosed Shiner; Moonfish.* H. L. Todd del.



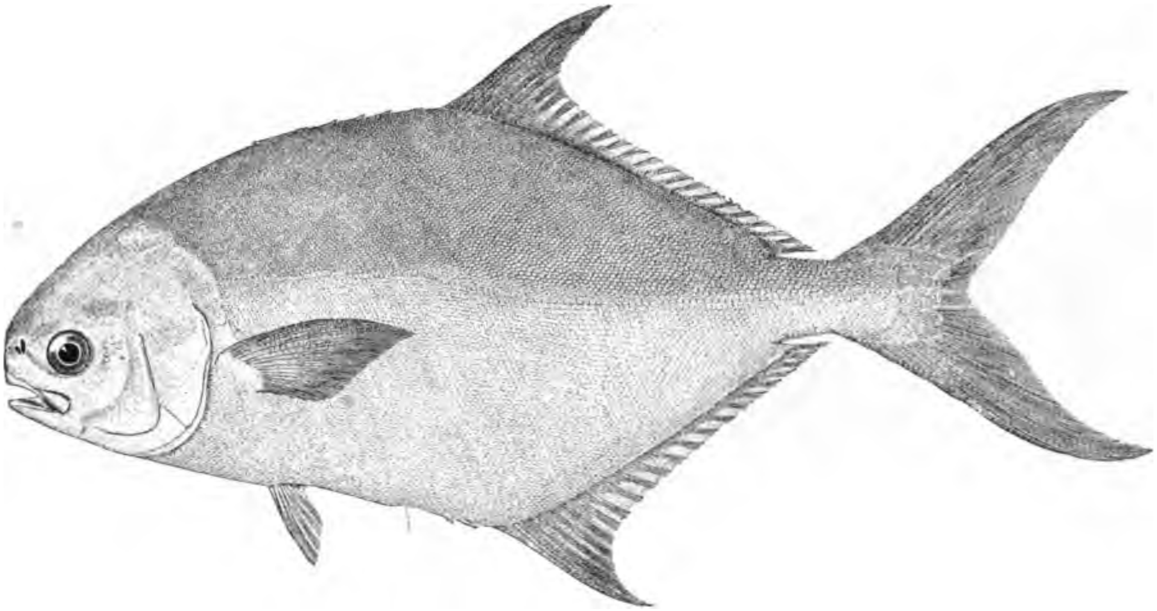
SELENE VOMER (Linnæus). *Silver Moonfish.* H. L. Todd del.



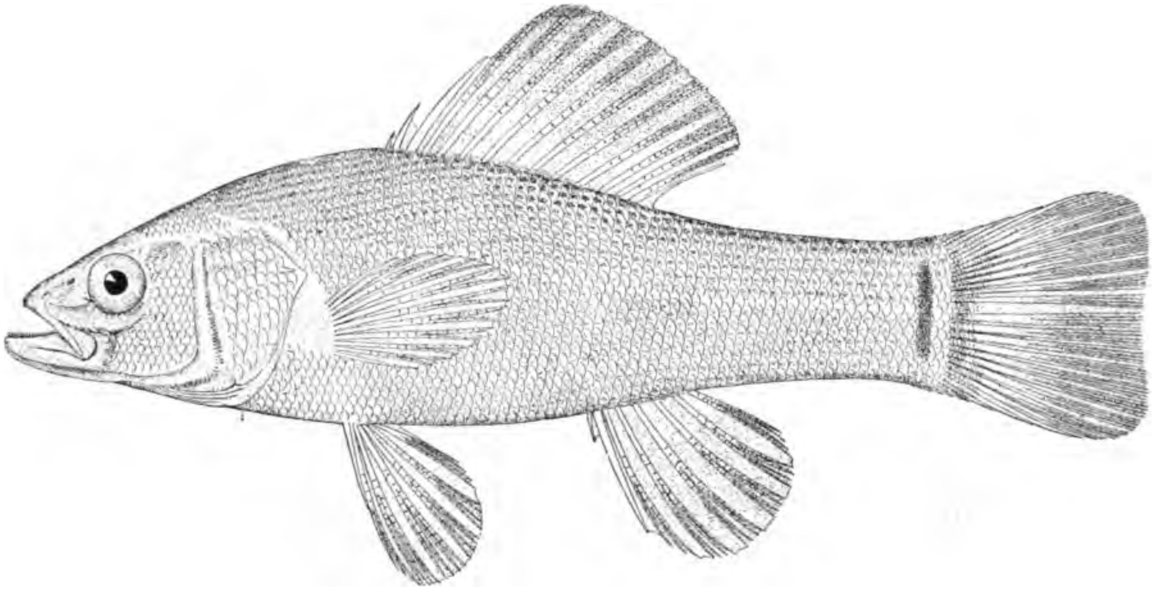
CARANX HIPPOS (Linnæus). *Horse Crevallé.* H. L. Todd del.



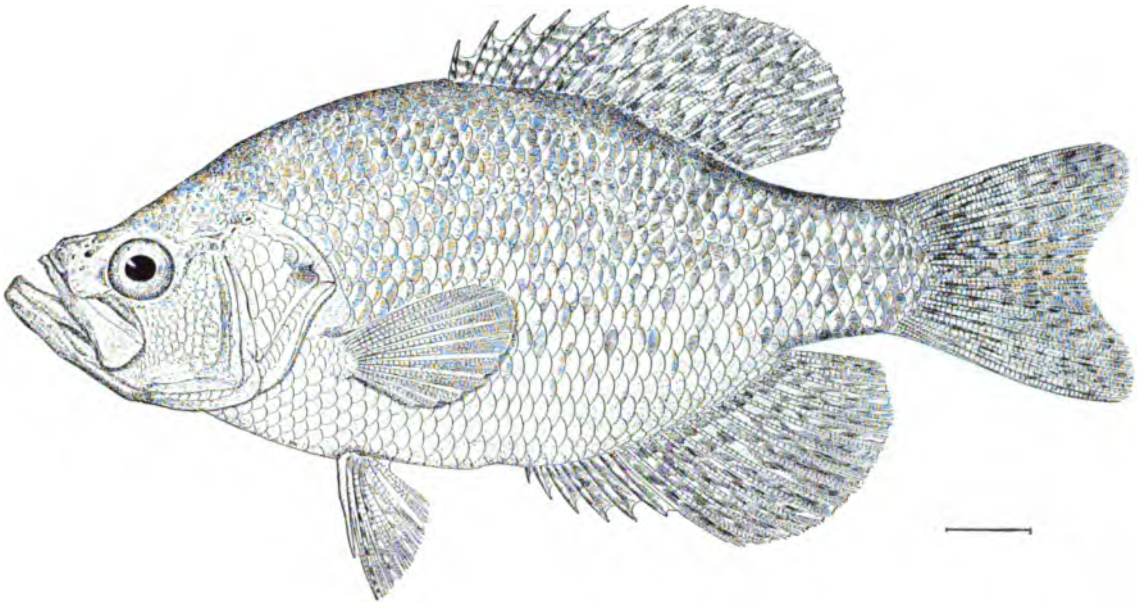
CHLOROSCOMBRUS CHRYSURUS (Linnæus). *Bumper.* St. Johns River, Florida. H. L. Todd del.



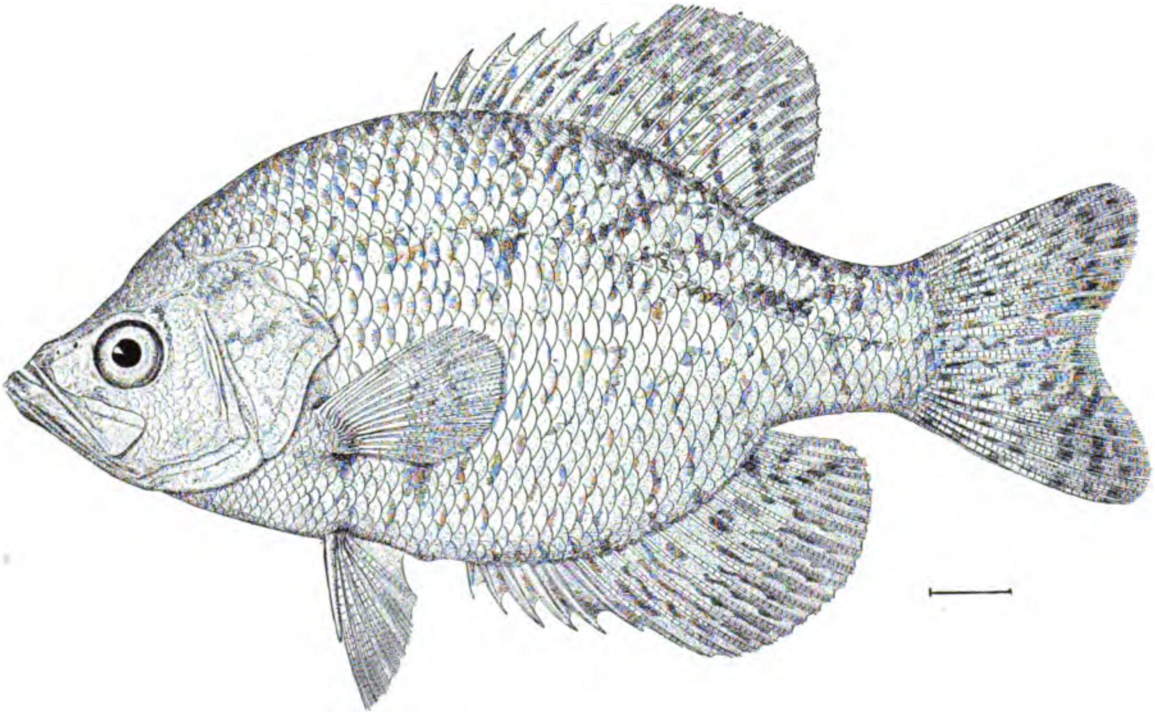
TRACHYNOTUS CAROLINUS (Linnæus). *Common Pompano.* H. L. Todd del.



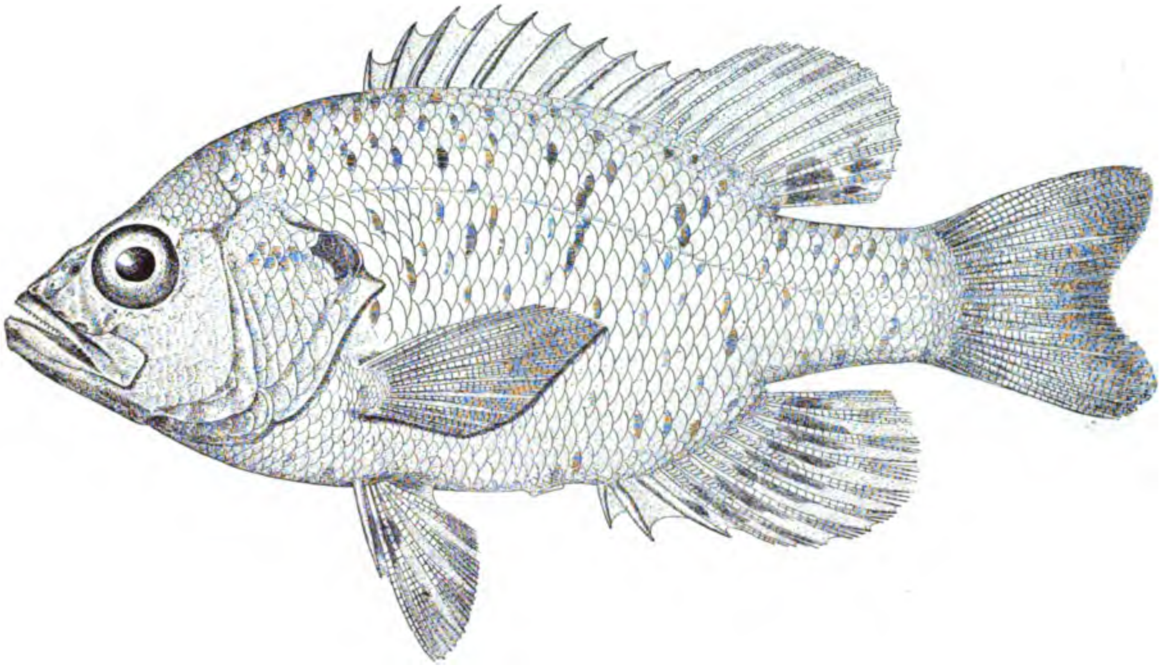
APHREDODERUS SAYANUS (Gilliams). *Pirate Perch.* Illinois River. H. L. Todd del.



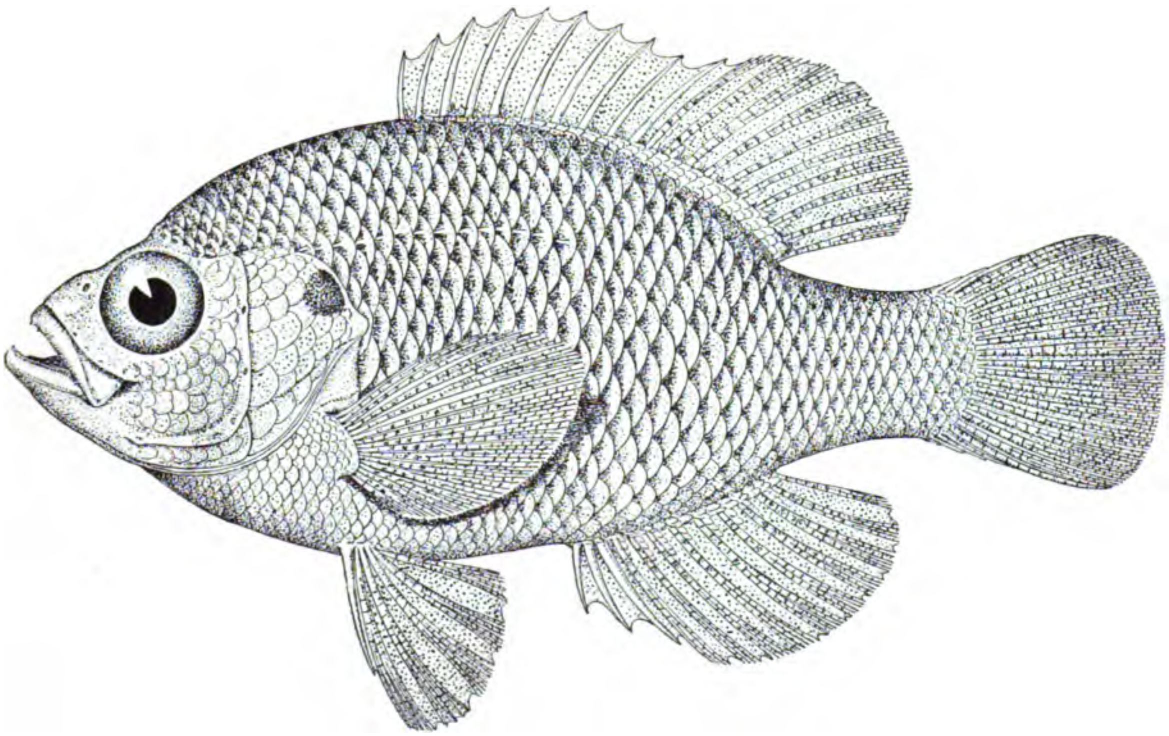
POMOXIS ANNULARIS Rafinesque. *Crappie; Sac-a-lait.* H. L. Todd del.



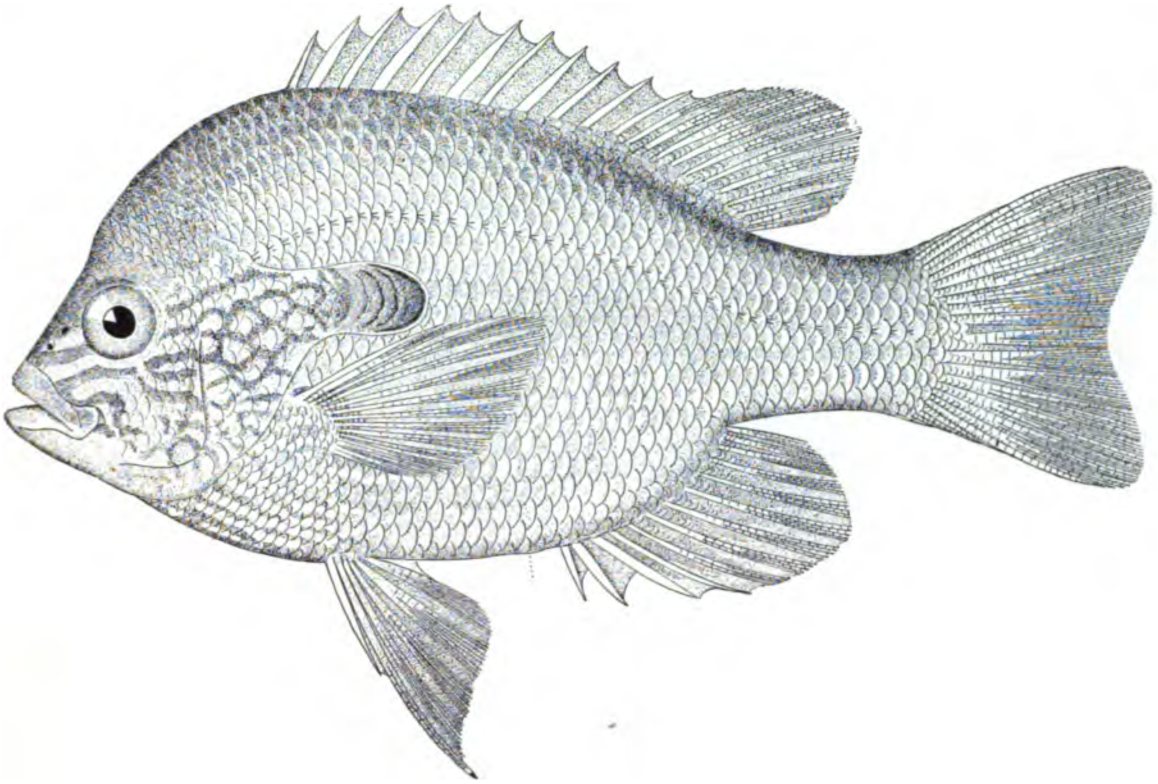
POMOXIS SPAROIDES (Lacépède). *Calico Bass; Sac-a-lait.* H. L. Todd del.



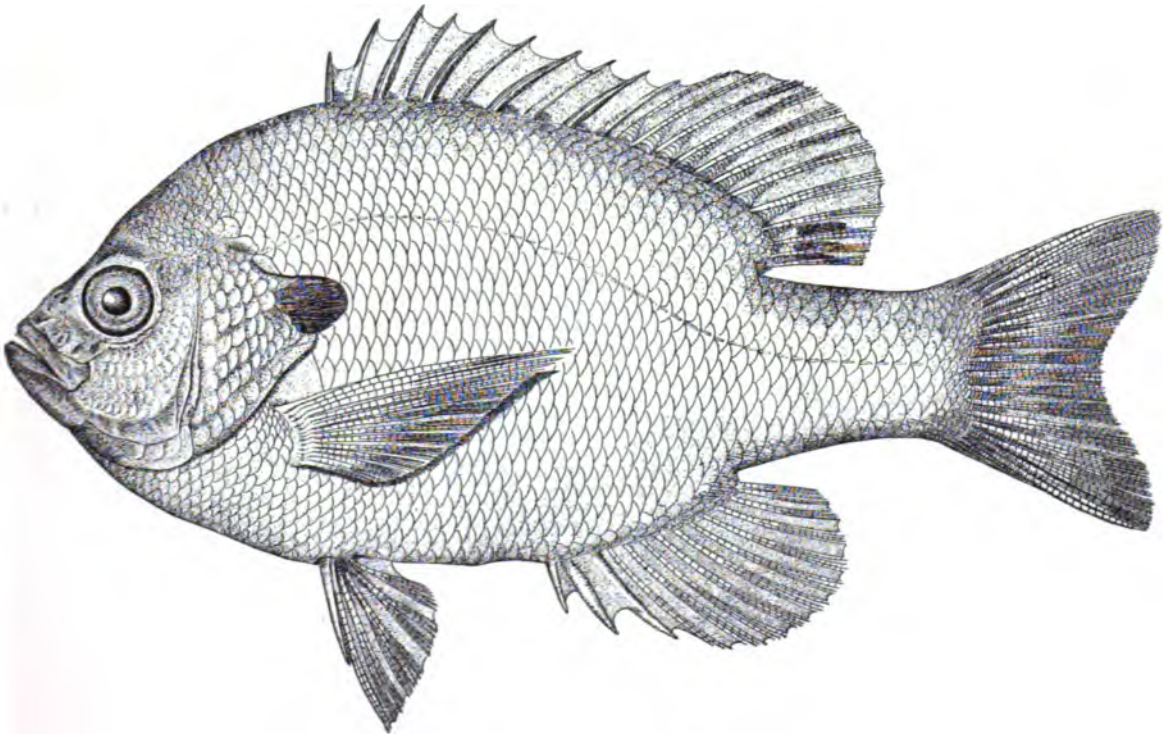
CHÆNOBRYTTUS GULOSUS (Cuvier & Valenciennes). *Warmouth.* H. L. Todd del.



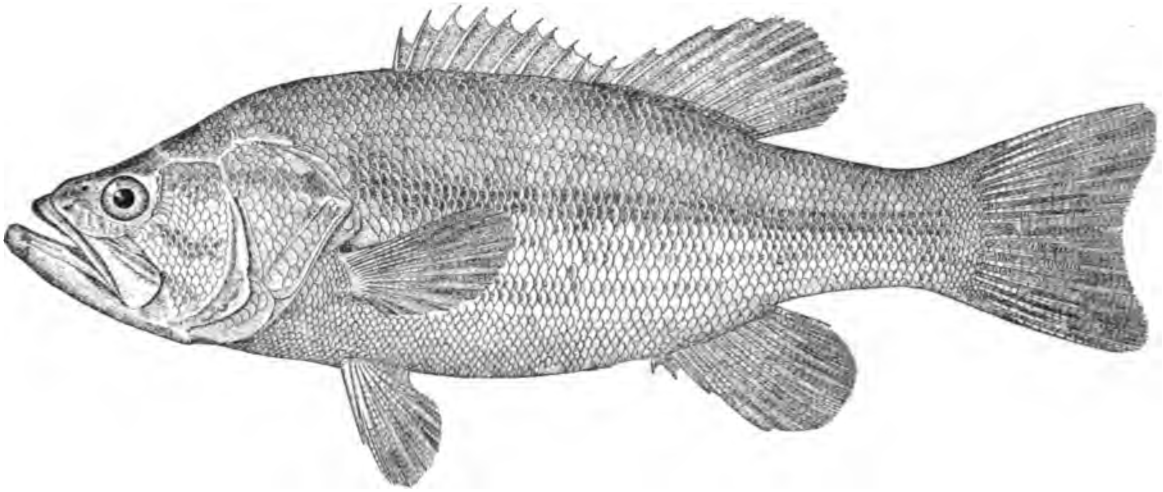
LEPOMIS SYMMETRICUS Forbes. Kilper's Pond, Houston, Texas. A. H. Baldwin del.



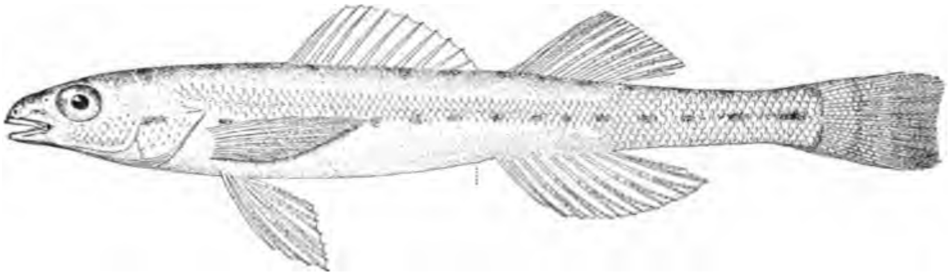
LEPOMIS MEGALOTIS (Rafinesque). *Large-eared Sunfish.* H. L. Todd del.



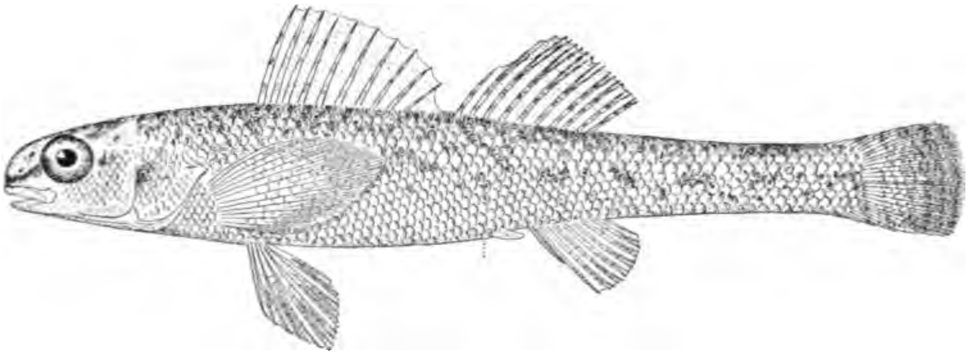
LEPOMIS PALLIDUS (Mitchill). ***Blue Sunfish; Blue-gill.*** H. L. Todd del.



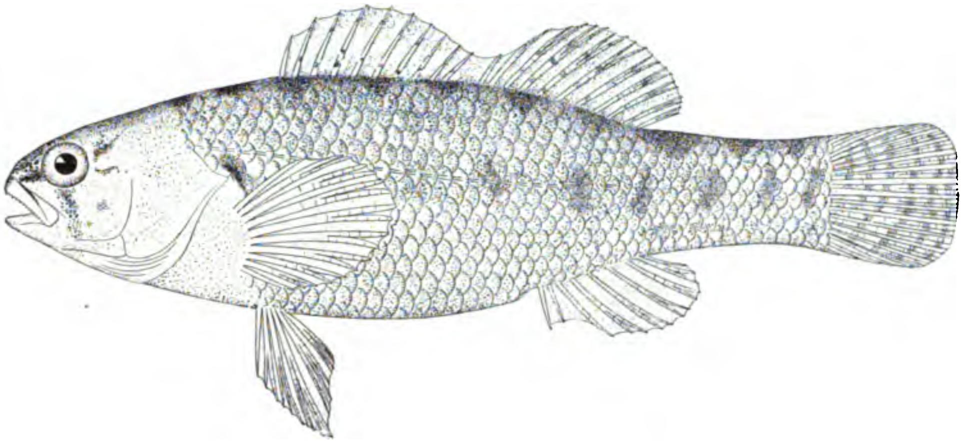
MICROPTERUS SALMOIDES (Lacépède). *Large-mouthed Black Bass.* Trout. H. L. Todd del.



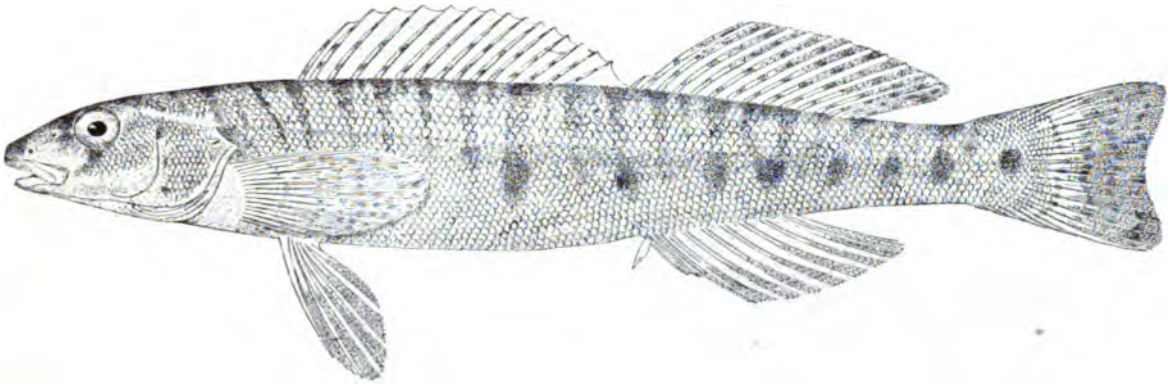
ETHEOSTOMA PELLUCIDUM CLARUM (Jordan & Meek). *Sand Darter.* Des Moines River, Ottumwa, Iowa. H. L. Todd del.



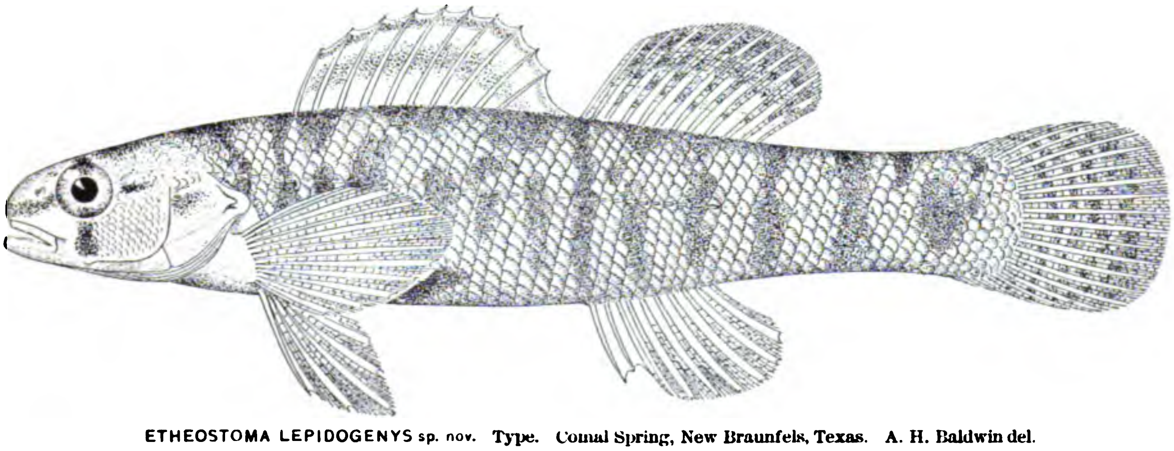
ETHEOSTOMA CHLOROSOMA Hay. Illinois River. H. L. Todd del.



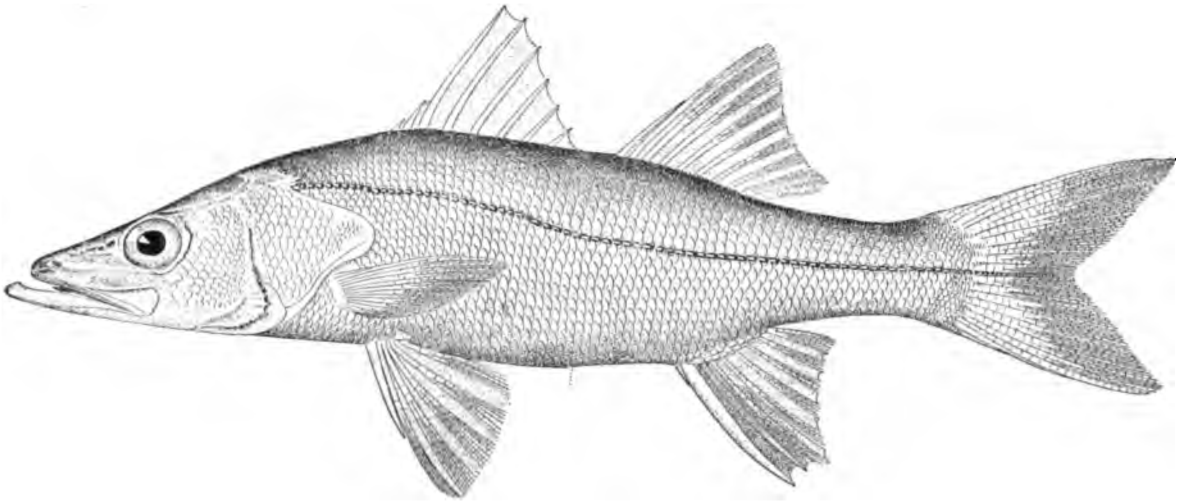
ETHEOSTOMA MICROPTERUS Gilbert. Chihuahua, Mexico. H. L. Todd del.



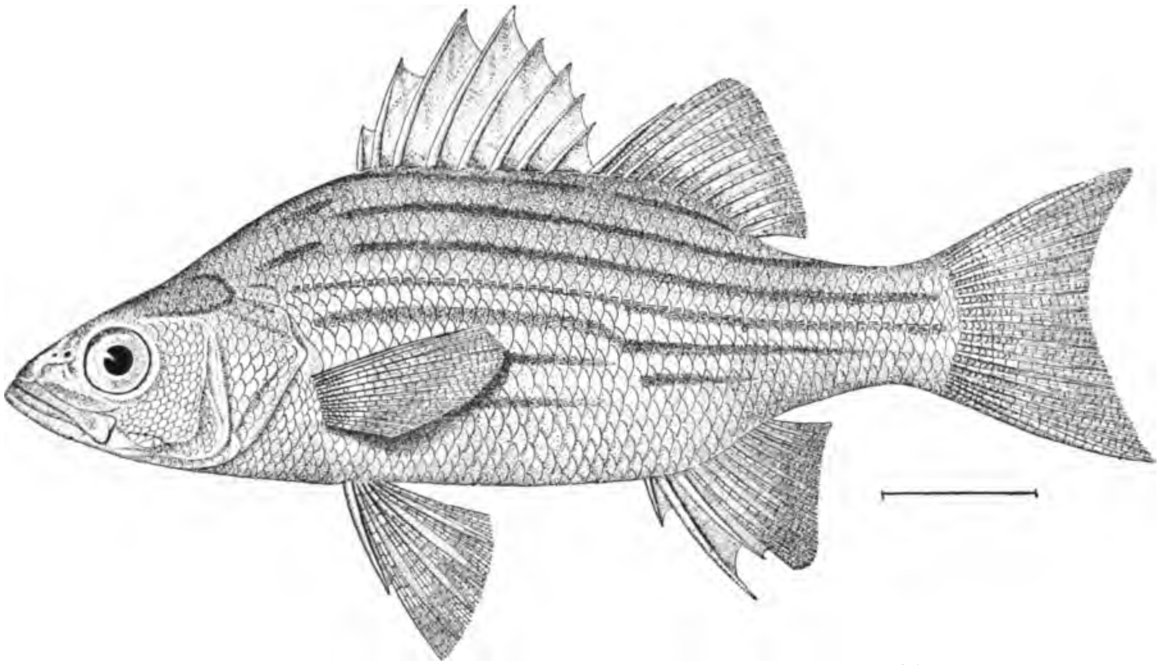
ETHEOSTOMA CAPRODES (Rafinesque). *Log Perch.* Licking River Reservoir, Ohio. H. L. Todd del.



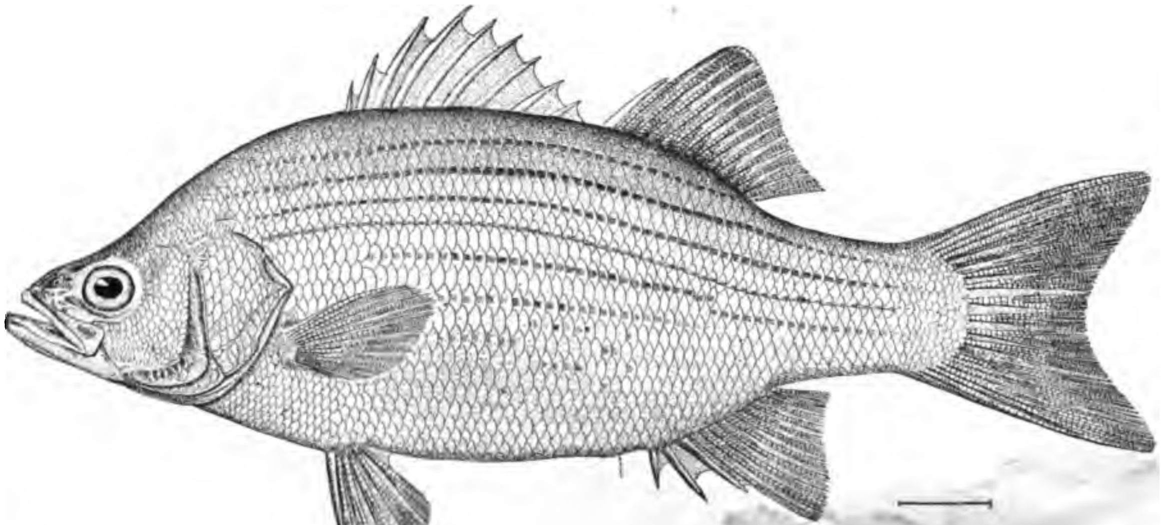
ETHEOSTOMA LEPIDOGENYS sp. nov. Type. Comal Spring, New Braunfels, Texas. A. H. Baldwin del.



CENTROPOMUS UNDECIMALIS (Bloch). Robalo. H. L. Todd del.

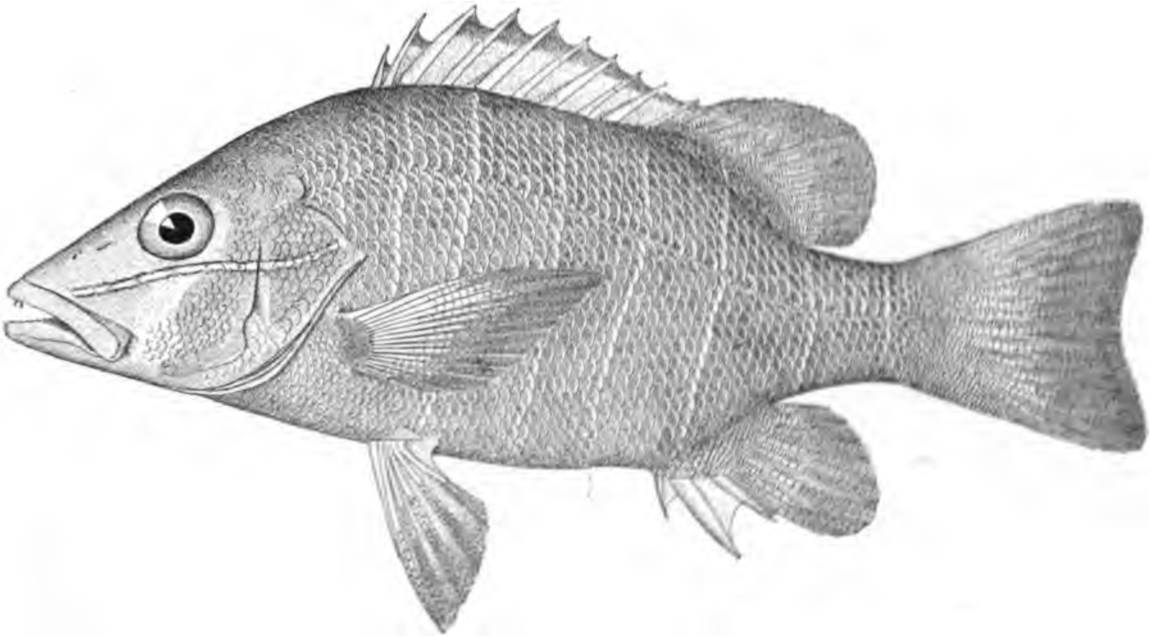


MORONE INTERRUPTA Gill. *Yellow Bass.* St. Louis, Missouri. H. L. Todd del.

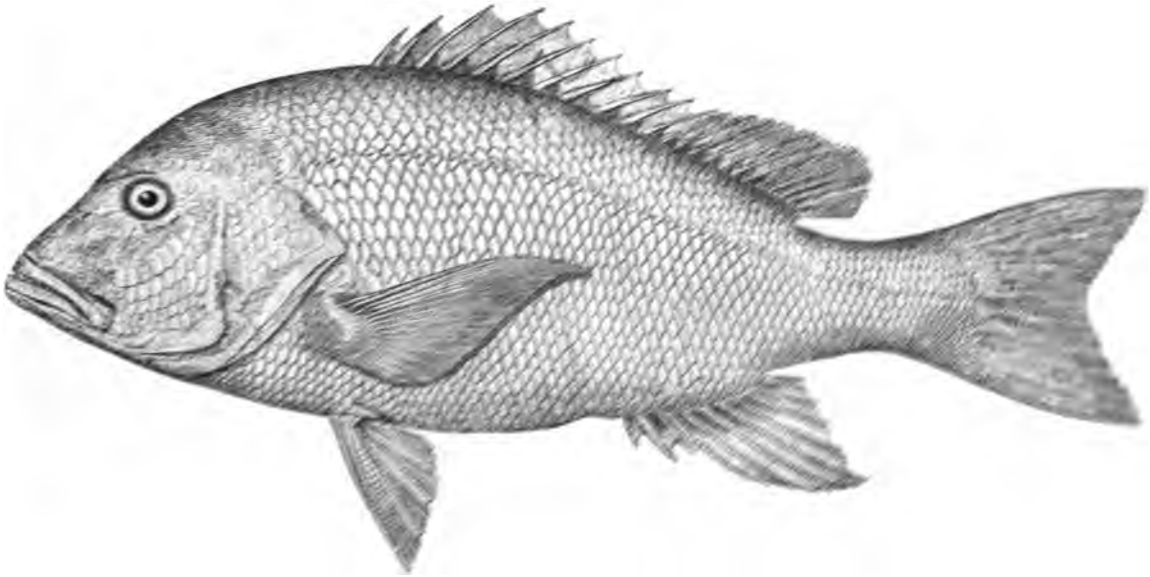


ROCCUS CHRYSOPS (Rafinesque.) *White Bass.* H. L. Todd del.

Bull. U. S. F. C. 1892. Fishes of Texas and the Rio Grande Region. (To face page 126.) PLATE XXXVIII.

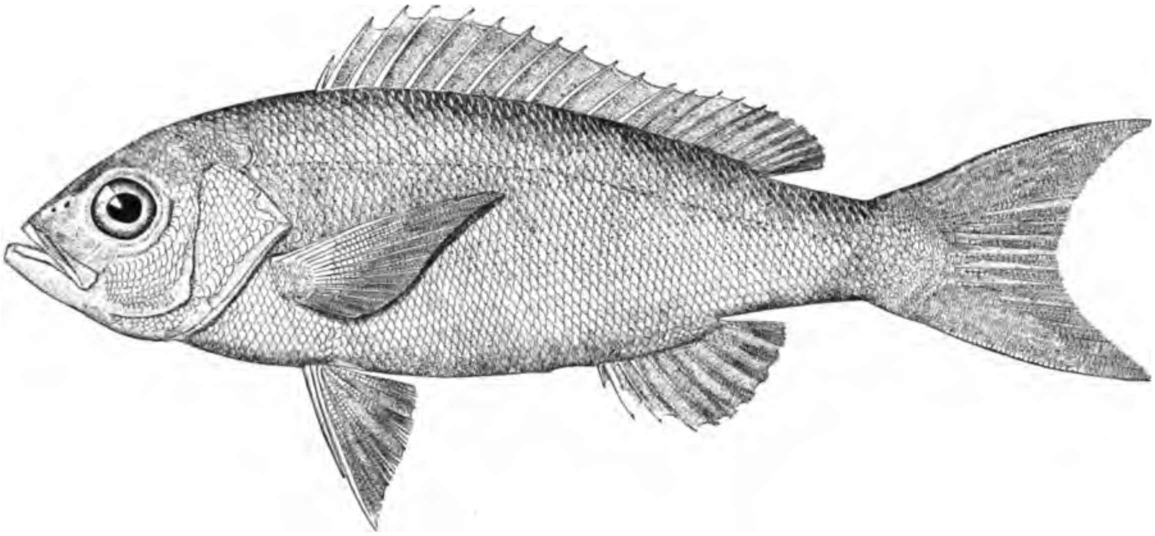


LUTJANUS CAXIS (Bloch & Schneider). *The Schoolmaster; Gray Snapper.* H. L. Todd del.

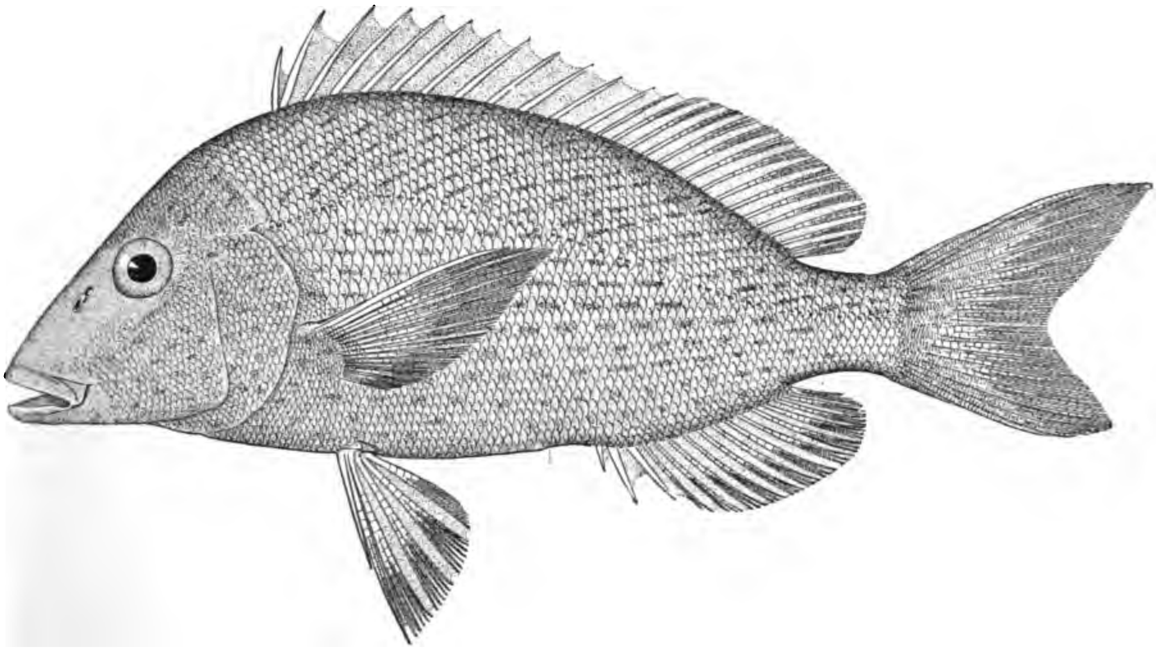


[illegible] *Red Snapper.* H. L. Todd del.

Todd del.



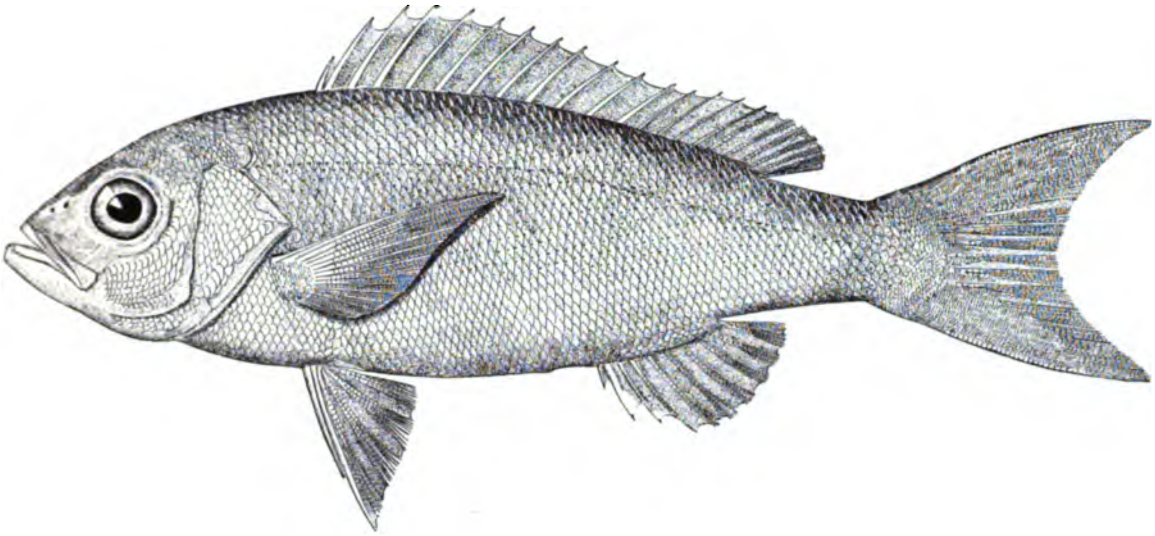
RHOMBOPLITES AURORUBENS Cuvier & Valenciennes. *Mangrove Snapper.* H. L. Todd del.



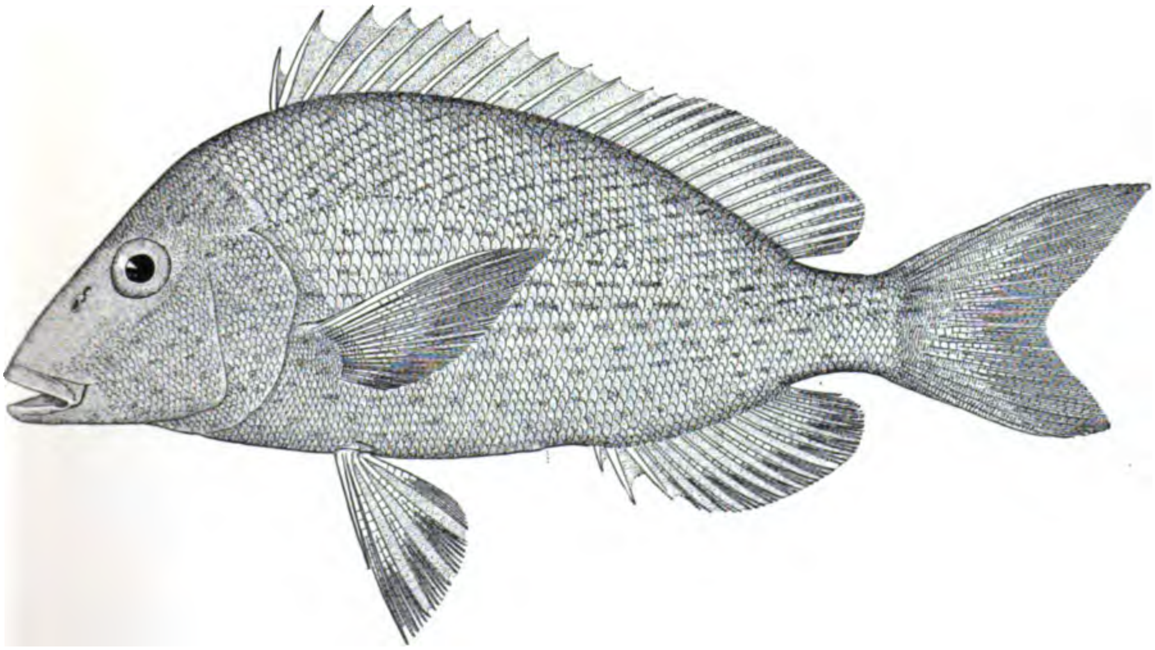
ORTHOPRISTIS CHRYSOPTERUS (Linnæus). *Hogfish; Grunt; Pigfish.* H. L. Todd del.

albaum). *Sheepshead*. . L. T

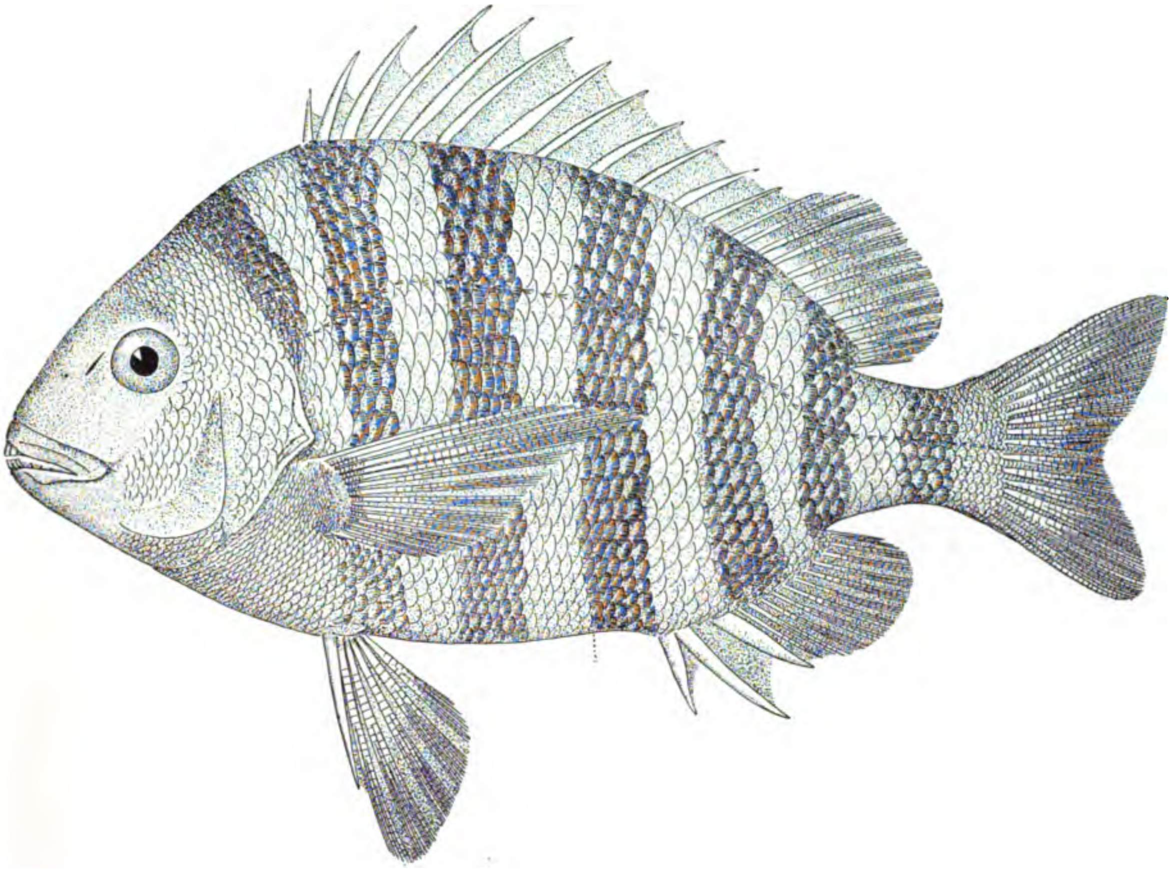
PLATE XXXIX.



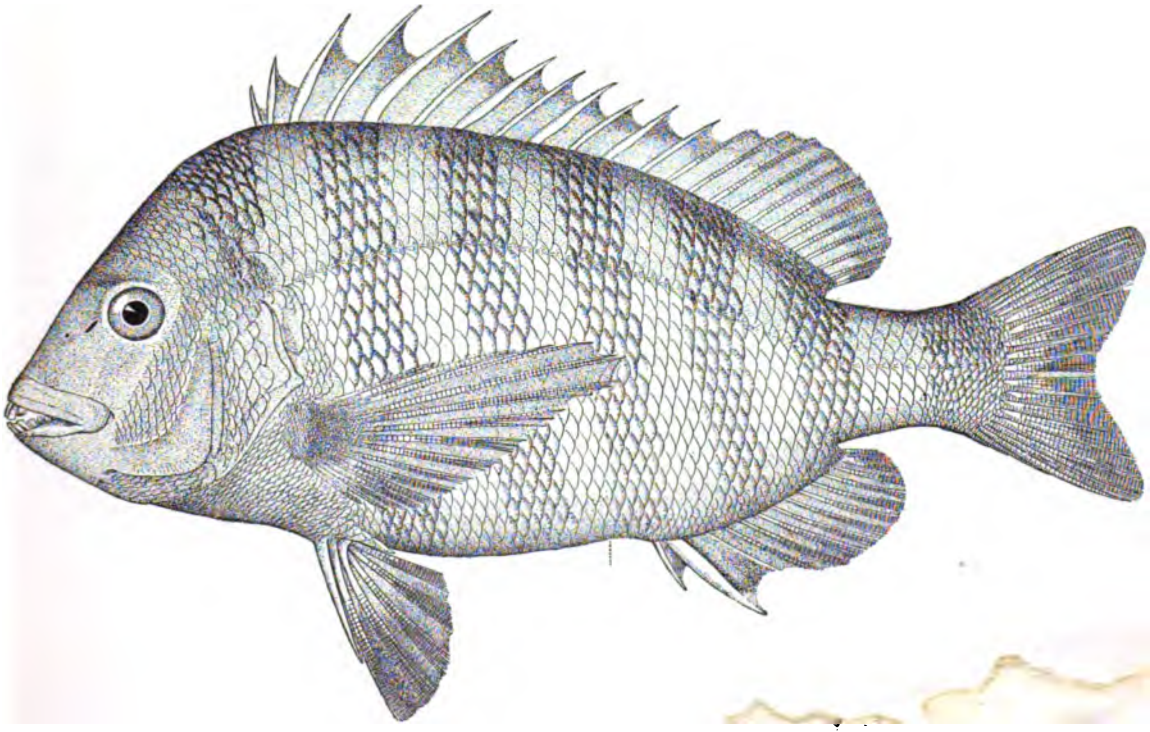
RHOMBOPLITES AURORUBENS Cuvier & Valenciennes. *Mangrove Snapper.* H. L. Todd del.



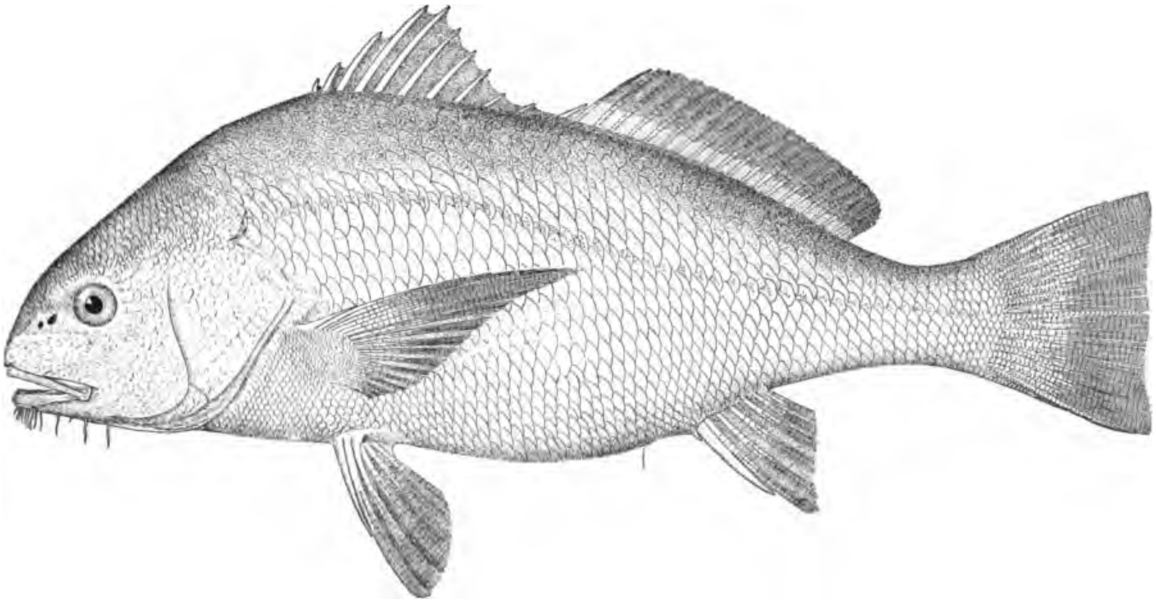
ORTHOPRISTIS CHRYSOPTERUS (Linnæus). *Hogfish; Grunt; Pigfish.* H. L. Todd del.



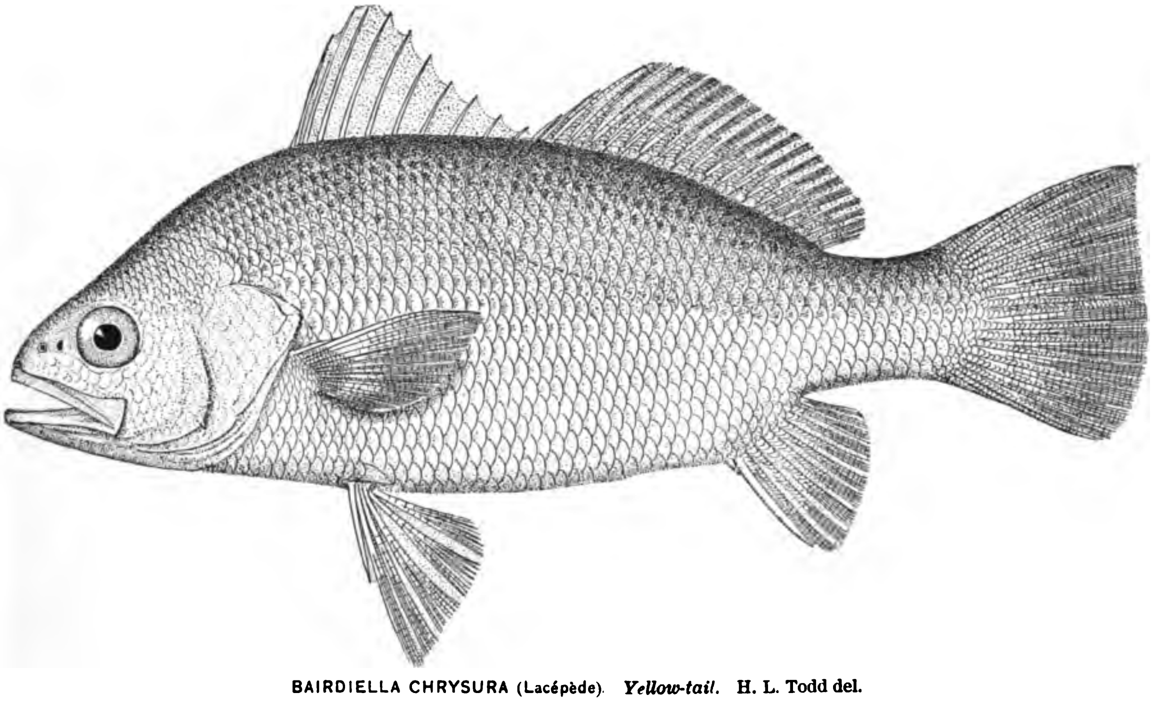
ARCHOSARGUS PROBATOCEPHALUS (Walbaum). *Sheepshead.* Young. H. L. Todd del.



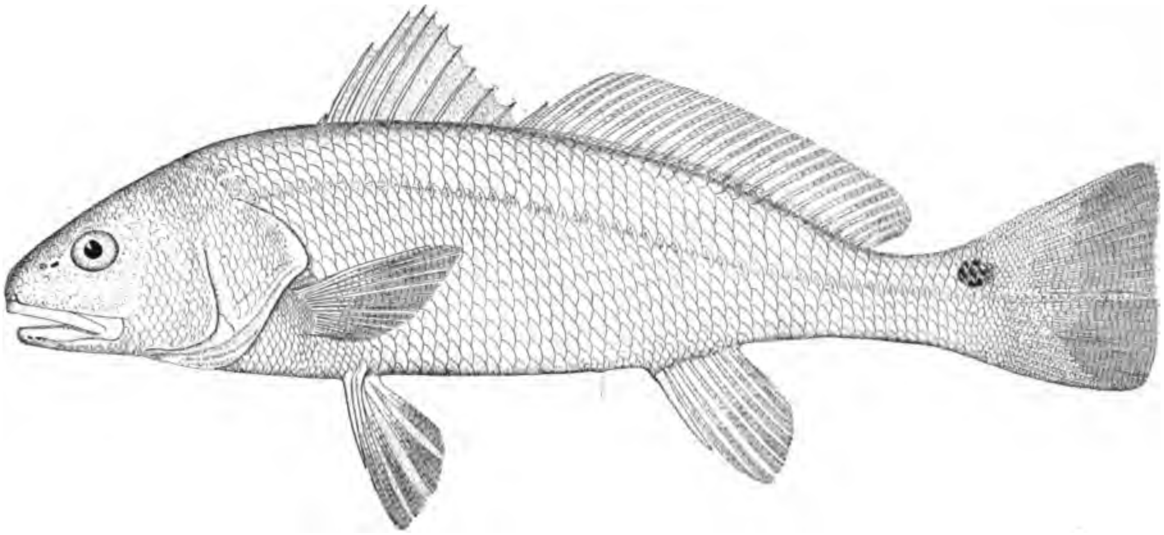
ARCHOSARGUS PROBATOCEPHALUS (Walbaum). *Sheepshead.* [illegible] L. T[illegible]



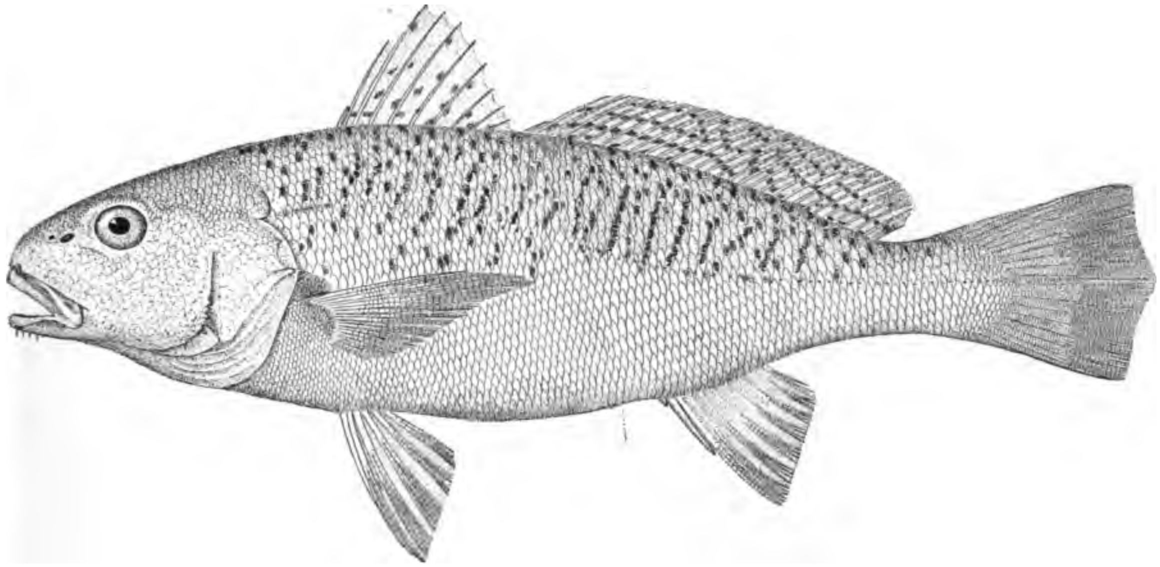
POGONIAS CROMIS (Linnæus). *Drum.* H. L. Todd del.



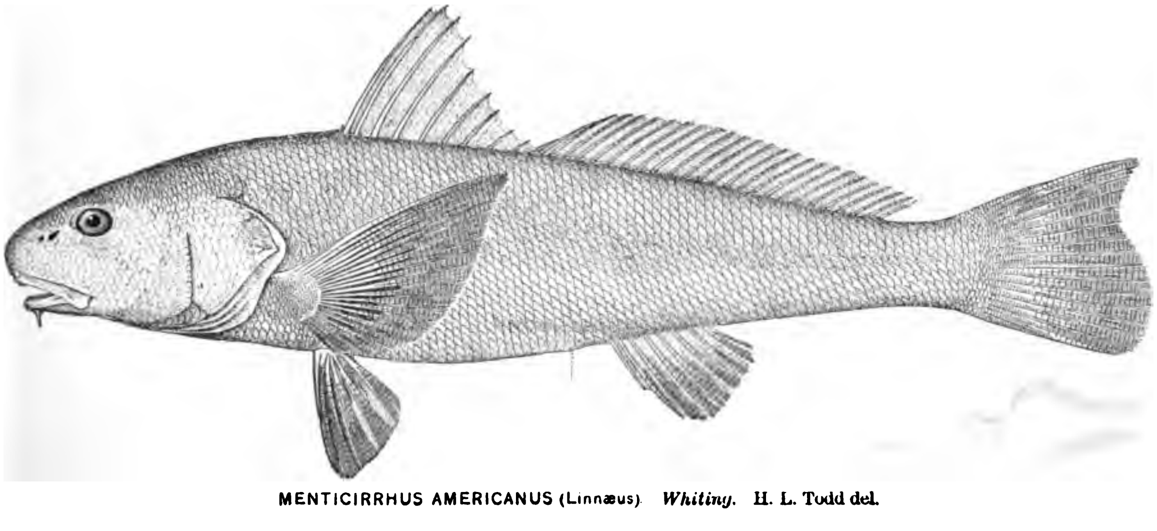
BAIRDIELLA CHRYSURA (Lacépède). *Yellow-tail.* H. L. Todd del.



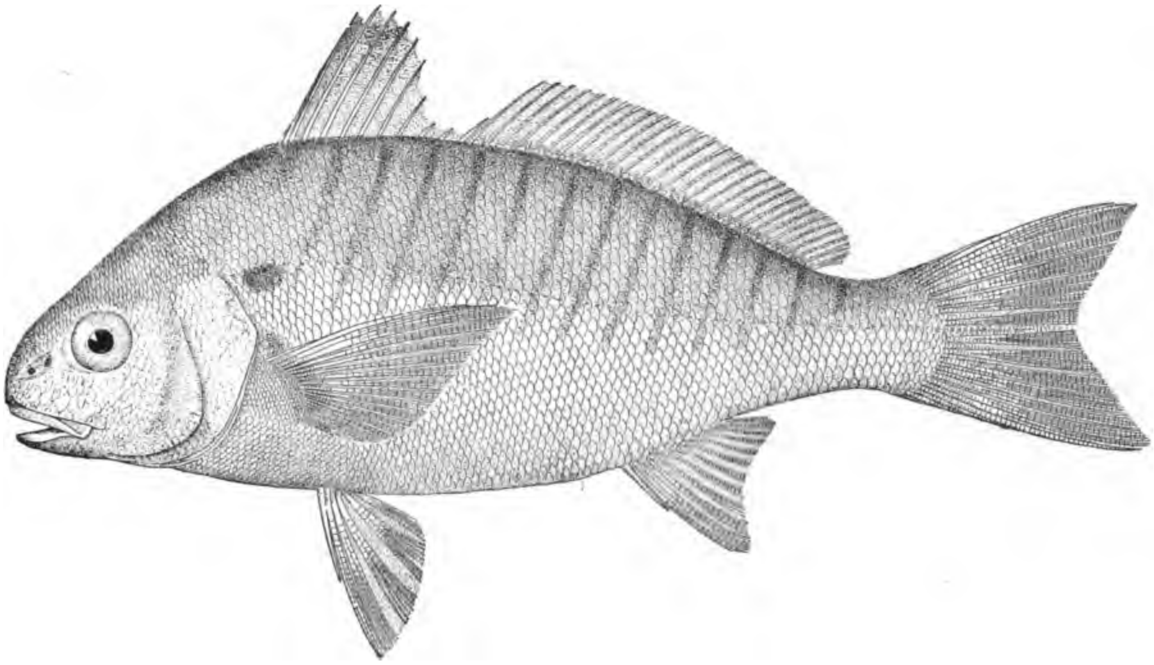
SCIÆNA OCELLATA (Linnæus). *Red Drum; Redfish.* H. L. Todd del.



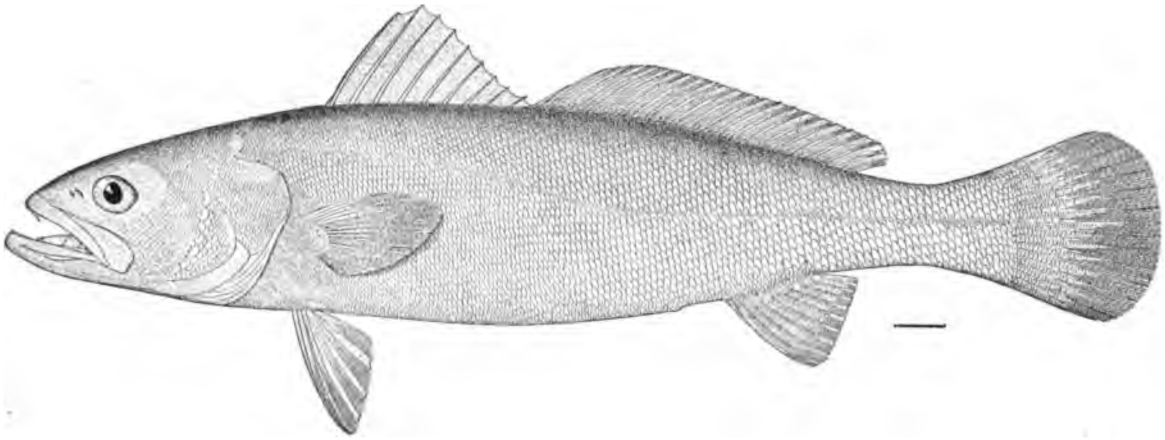
MICROPOGON UNDULATUS (Linnæus). *Croaker.* H. L. Todd del.



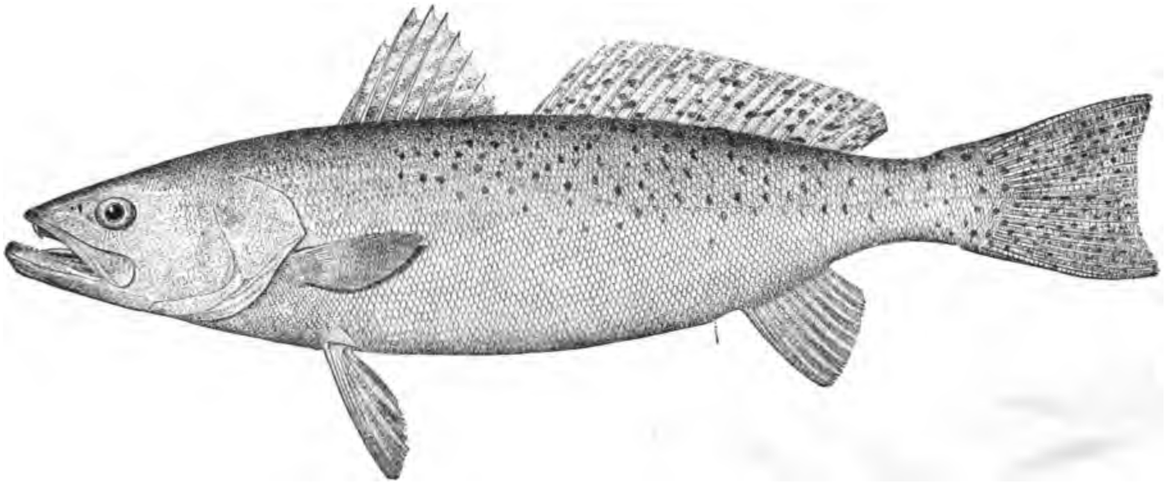
MENTICIRRHUS AMERICANUS (Linnæus). *Whiting.* H. L. Todd del.



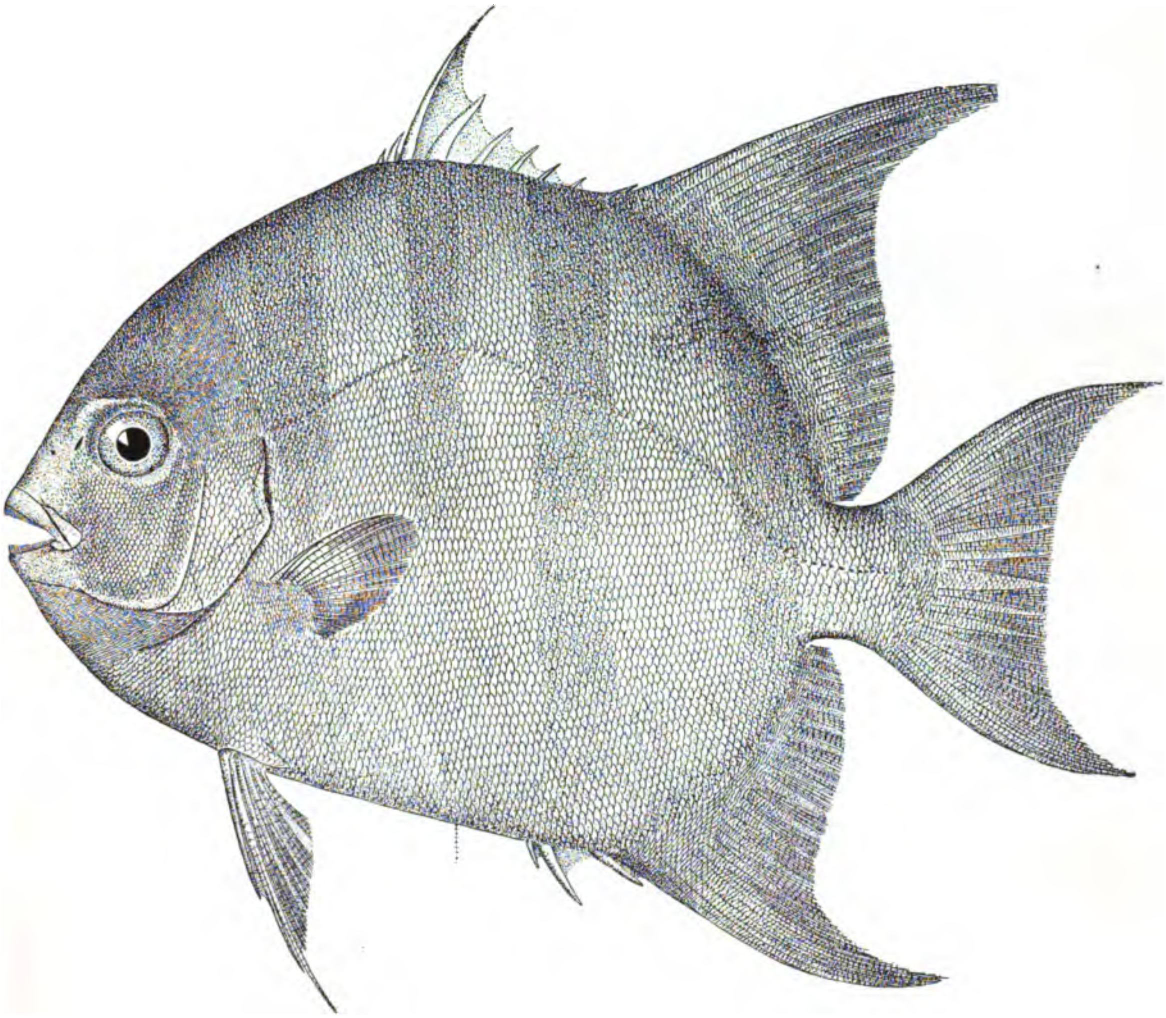
LEIOSTOMUS XANTHURUS Lacépède. *Spot.* H. L. Todd del.



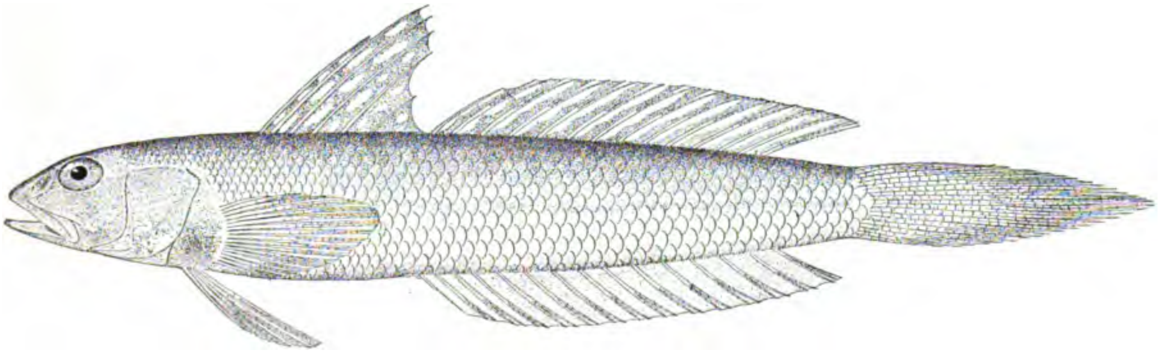
CYNOSCION NOTHUS (Holbrook). Trinidad, West Indies. H. L. Todd del.



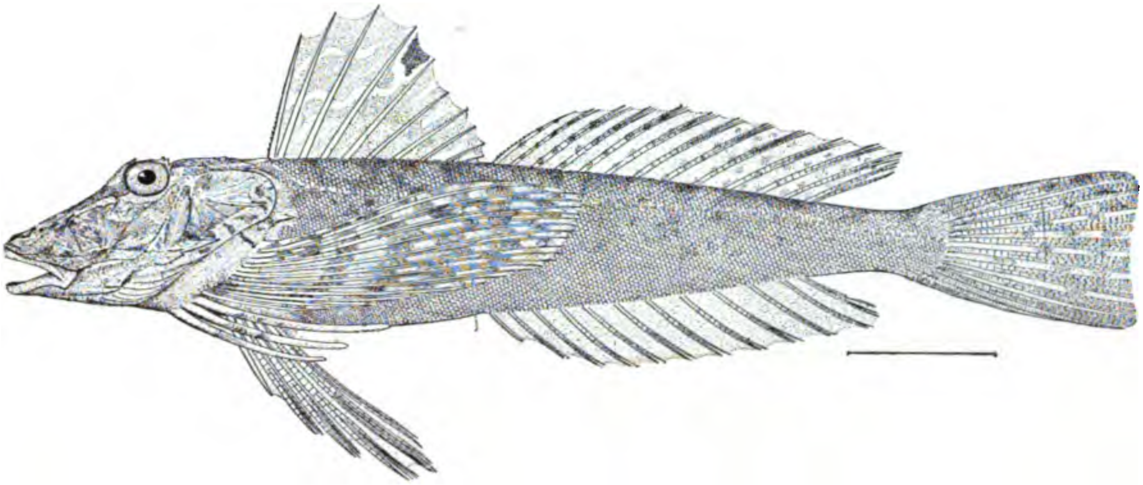
CYNOSCION NEBULOSUS (Cuvier & Valenciennes). *Spotted Sea Trout.* H. L. Todd del.



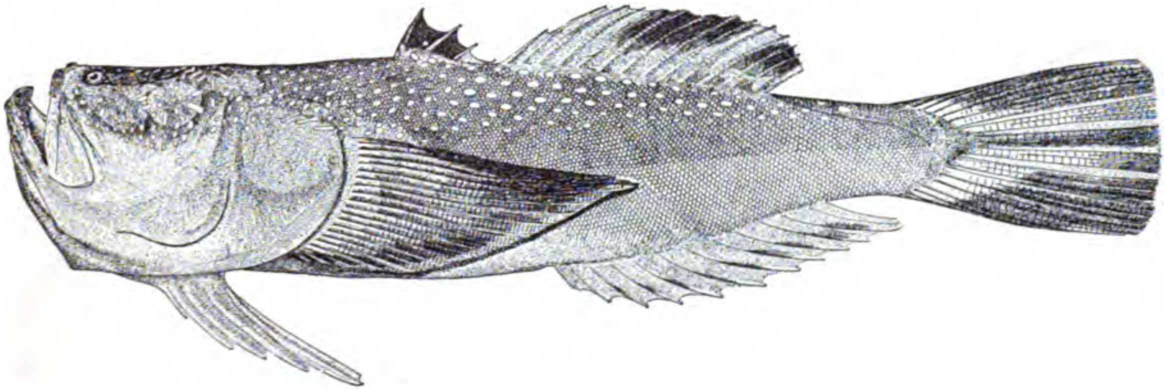
CHÆTODIPTERUS FABER (Broussonet). *Angel-fish; Moonfish.* H. L. Todd del.



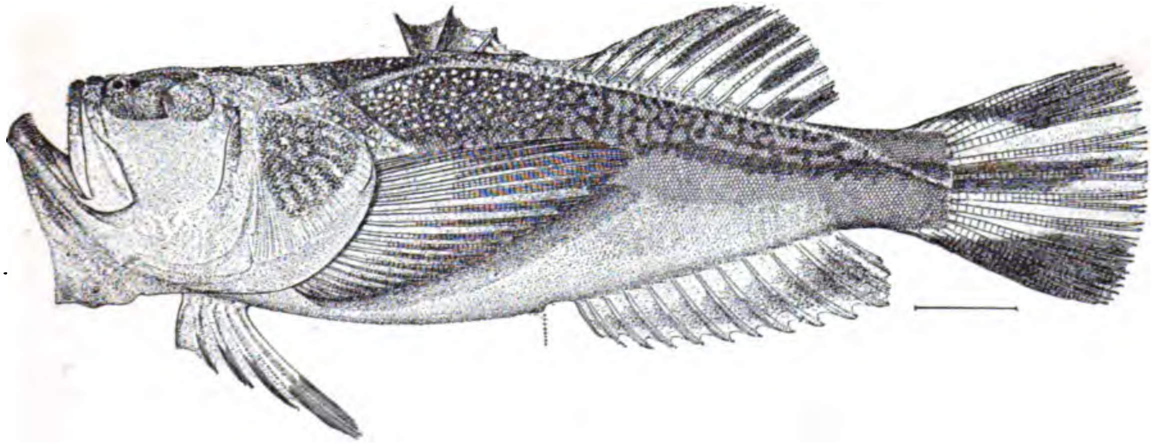
GOBIONELLUS OCEANICUS (Pallas). *Emerald Fish.* Key West, Florida. H. L. Todd del.



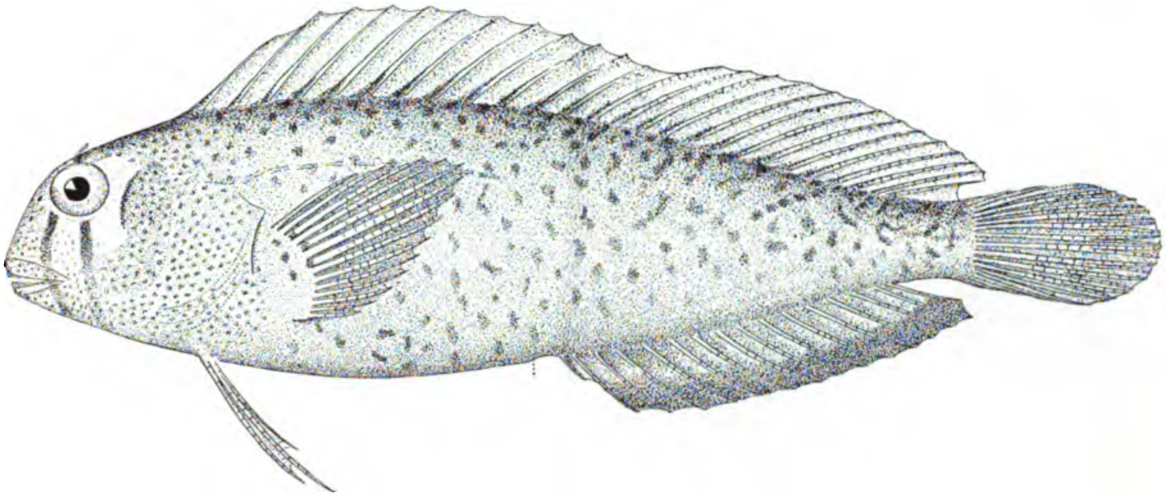
PRIONOTUS SCITULUS Jordan & Gilbert. *Sea Robin.* Florida. H. L. Todd del.



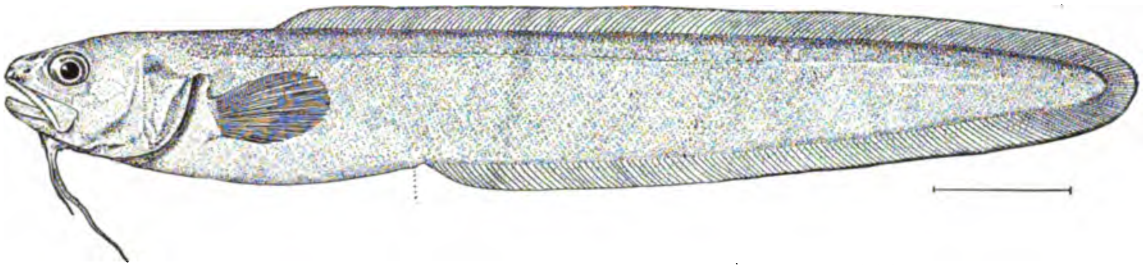
UPSILONPHORUS Y-GRÆCUM (Cuvier & Valenciennes). *Star-gazer.* Matanzas River Inlet, Florida. H. L. Todd del.



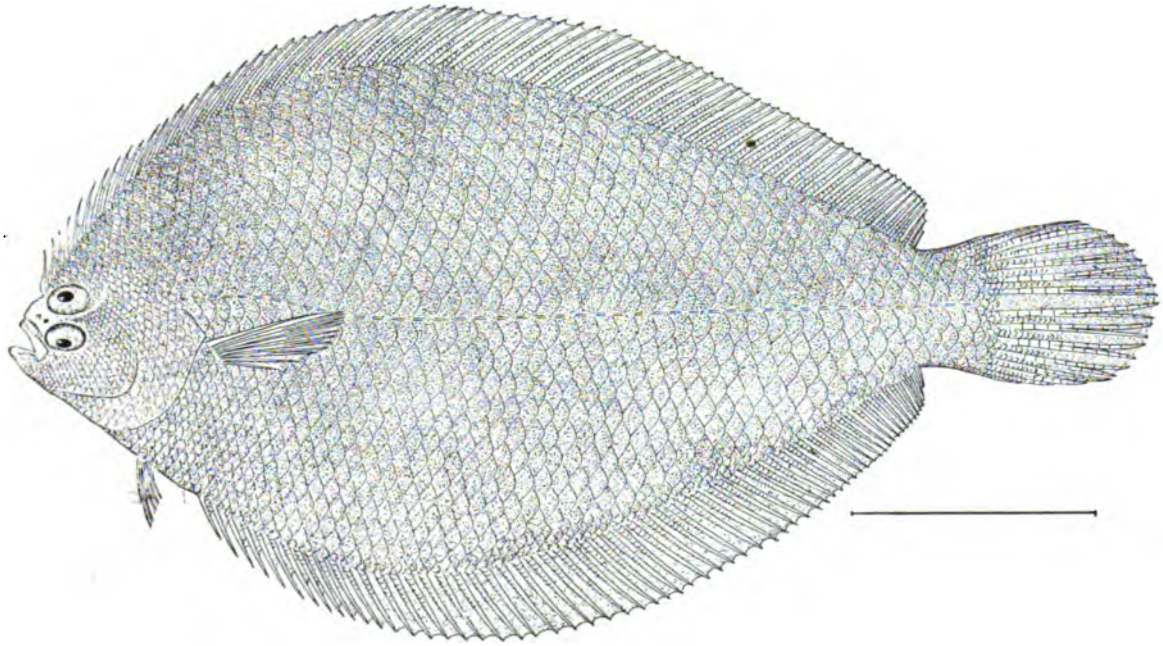
ASTROSCOPUS ANOPLOS (Cuvier & Valenciennes). *Electric Dog-fish.* Norfolk, Virginia. H. L. Todd del.



ISESTHES IONTHAS Jordan & Gilbert. *Blenny.* Pensacola, Florida. H. L. Todd del.

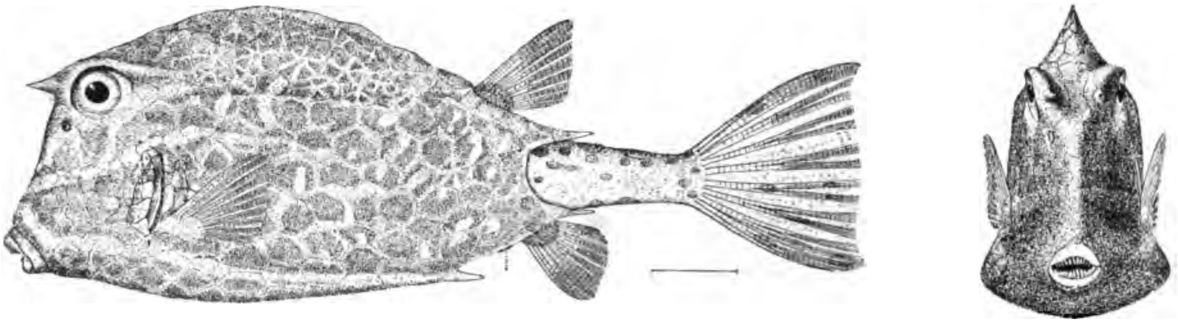


OPHIDION MARGINATUM De Kay. Tompkinsville, New York. H. L. Todd del.

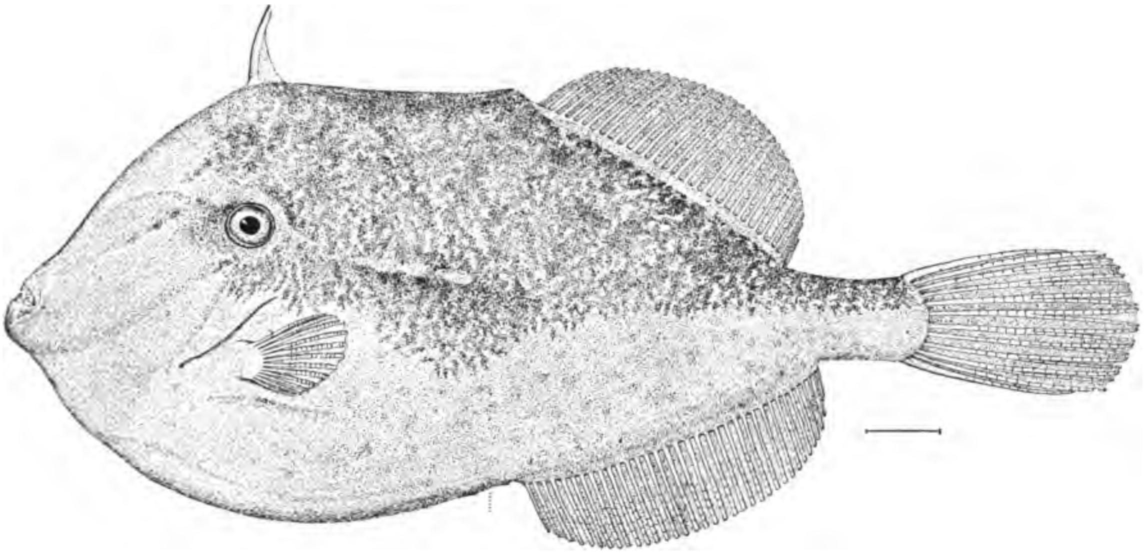


ETROPUS CROSSOTUS Jordan & Gilbert. Cedar Keys, Florida. H. L. Todd del.

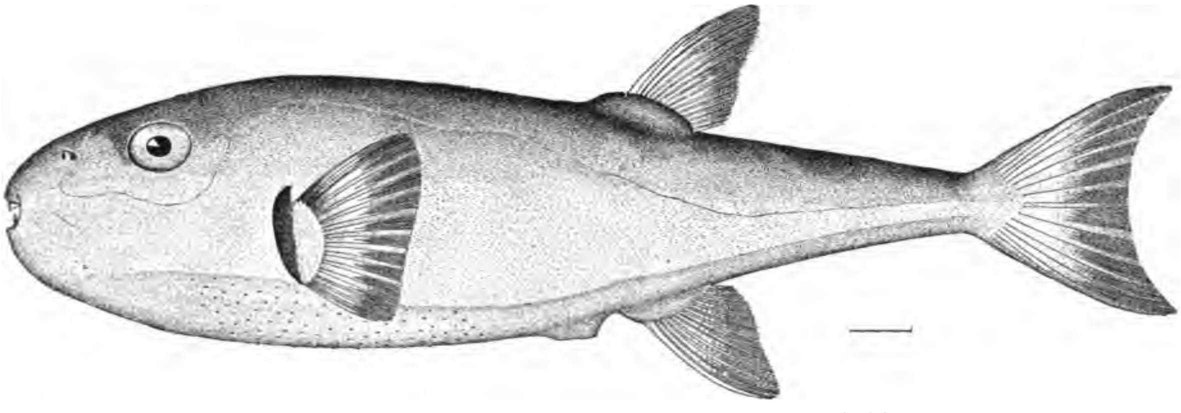
PLATE XLIX.



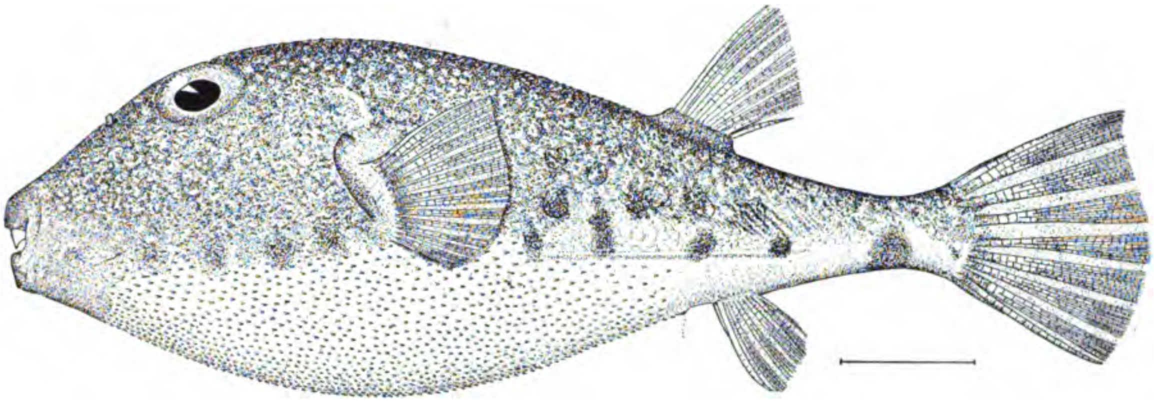
OSTRACION TRICORNE Linnæus. *Cowfish.* Charleston, South Carolina. H. L. Todd del.



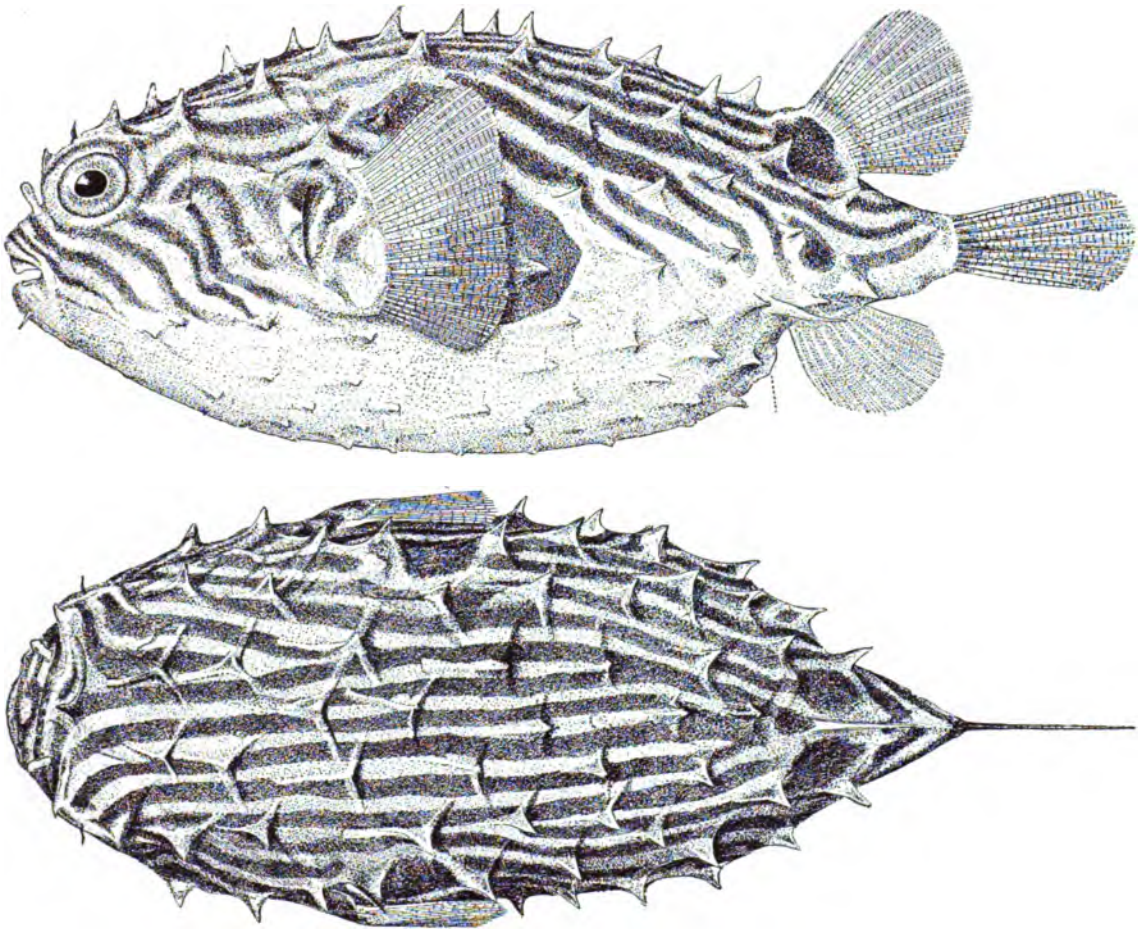
ALUTERA SCHŒPFFI (Walbaum). *Orange Filefish.* Cedar Keys, Florida. H. L. Todd del.



LAGOCEPHALUS LÆVIGATUS (Linnæus). *Smooth Puffer.* H. L. Todd del.



TETRODON NEPHELUS (Goode & Bean). *Swellfish Puffer.* Indian River, Florida. H. L. Todd del.



CHILOMYCTERUS SCHŒPFFI (Walbaum). *Swell-toad; Burrfish.* Side and dorsal views. Noank, Connecticut.
H. L. Todd del.

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4.—SUMMARY OF THE FISHERY INVESTIGATIONS CONDUCTED IN THE NORTH PACIFIC OCEAN AND BERING SEA FROM JULY 1, 1888, TO JULY 1, 1892, BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

BY RICHARD RATHBUN.

INTRODUCTION.

The building, in 1882, of a staunch sea-going steamer, thoroughly equipped for the purposes of the U. S. Fish Commission, afforded, for the first time, the proper means for studying the extensive ocean fishing-grounds adjacent to the Atlantic seacoast of the United States. During the five years following her completion the steamer *Albatross* was actively employed, and with marked success, in this special field of work, the region covered by her operations extending from off Newfoundland to the northern shores of South America. The interest aroused by these investigations, the utility of which had been fully demonstrated, led to a demand for the transfer of the *Albatross* to the North Pacific Ocean, a proposition which met the approval of the late Commissioner of Fisheries, Prof. Spencer F. Baird, and was later sanctioned by Congress. Extensive arrangements were necessary in preparation for so long a cruise, but they were satisfactorily completed in the fall of 1887, and on November 21 of that year the ship left Norfolk, Va., for San Francisco.

The first systematic researches bearing upon the economic marine fishes of the western coast of North America were conducted in 1879 and 1880, by Dr. David S. Jordan and Prof. Charles H. Gilbert, for Washington, Oregon, and California, and by Dr. Tarleton H. Bean, for Alaska. Not having suitable facilities for investigating the fishing-grounds, the work of these naturalists was chiefly limited to collecting and studying the fishes obtainable along the shores and from the fishermen, but, nevertheless, exceedingly important results were accomplished by them. These have been published in the reports of the Fish Commission and in the Proceedings of the U. S. National Museum, the series of volumes entitled the Fisheries and Fishery Industries of the United States containing full accounts of their observations relative to fishery matters, as well as a complete review of this entire subject down to 1882. The same information has also been summarized in the Bulletin of the Fish Commission for 1888, in connection with the first report upon the explorations of the *Albatross* in the North Pacific Ocean.[*] A reference to these papers shows that, while a few cod-fishing vessels were accustomed to resort to certain places in Bering Sea and off the south side of the Alaska Peninsula, very little was then known regarding the extent and characteristics of the Alaskan fishing-grounds, only a comparatively few soundings had been made to ascertain the depths of water at any distance from the land, and the limits of the continental platform were almost wholly undetermined. Respecting the coasts of Washington, Oregon, and California even less information was at hand, Dr. Jordan stating that—

> Except the salmon fisheries of the Sacramento and the Columbia and the ocean fisheries in the immediate vicinity of San Francisco, the fisheries of the Pacific coast exist only as possibilities. For the most part only shore fishing on the smallest scale is done, and no attempt is made to discover offshore banks, or to develop them when discovered.

Being specially equipped for hydrographic as well as fishery inquiries, the *Albatross* was well adapted to undertake the investigation of this practically new region, in which, at the outset, the delineation of the bottom was fully as important as the determination of its food resources. She is an iron, twin-screw propeller of 1,000 tons displacement, measures 234 feet in total length, and is rigged as a brigantine. The hull is modeled with reference to the peculiar character of her movements, and she is provided throughout with the most approved appliances for the different branches of research in which she is expected to engage, many of them being a direct outgrowth of the Fish Commission work. Sounding is carried on by means of fine piano wire, operated by a Sigsbee steam and a Tanner hand machine, both working on the principle first demonstrated by Sir William Thomson. Iron rope is employed for dredging, the machinery used in connection with it consisting of a heavy hoisting engine on the spar deck forward, and a reeling engine on the berth deck underneath, together with all the necessary auxiliary apparatus to insure its smooth running. The outfit supplied for physical and fishery observations comprises the means of studying the temperature, density, etc., and of collecting animals in all depths of water, the latter including a large assortment of dredges, beam trawls, and tangles, as well as all the ordinary forms of fishing gear.

The program arranged for the steamer *Albatross* contemplated, in the beginning, a somewhat rapid survey or reconnoissance along the entire western coast line, with the object of ascertaining the contour and condition of the bottom wherever the depths were suitable for fishing, the positions and outlines of all distinctive fishing-grounds, and the character and abundance of the food resources. Such an investigation could not fail to yield immediate results, by supplying early information to the fishermen to guide them in seeking favorable localities for the prosecution of their work, and it would also serve as the basis for the more complete development of important regions or of special branches of fishing. The *Albatross* reached San Francisco in May, 1888, and within three years from that time she had completed these preliminary surveys from San Diego to the Strait of Juan de Fuca; along the southern side of the Alaska Peninsula, from Middleton Island to Unalaska; and in the southeastern part of Bering Sea, from Unalaska to the head of Bristol Bay and Cape Newenham. Since June, 1891, she has been detailed to study certain problems respecting the habits of the fur seals in the North Pacific Ocean and Bering Sea, and to make the survey for a cable route between California and the Hawaiian Islands, neither of which subjects, however, is discussed in this paper.

The width of the area covered by the fishery explorations of the *Albatross* has been regulated mainly by the depth of water, having extended from the shallow soundings close along the shore to the abrupt outer margin of the continental platform. The object has been to carry the examinations over the entire surface of this platform, into depths of 100 and 200 fathoms, but in order to locate these curves with accuracy it has been necessary to extend the lines of soundings into somewhat deeper water, with the result of contributing very important data of general hydrographic interest. Bottom fishing is rarely carried on beyond a depth of 200 fathoms, and in a new region it will be limited for many years to much shallower water. The sounding work, as indicating the general contour of the bottom, has, therefore, been sufficiently extensive for this purpose over the area so far explored, but more detailed surveys will be required in some localities, especially where the bottom is irregular and the fishery resources are rich enough to call for additional information of that character.

The summary of the operations of the *Albatross* herewith presented gives, in geographical sequence, the principal information of interest to the fishermen, which has been gathered during the several cruises in the North Pacific Ocean and to Bering Sea. It is based mainly upon the narrative reports of the commanding officer and his civilian assistants, but is necessarily very incomplete, as only a comparatively small part of the extensive natural-history collections obtained has yet been studied and described. It is considered, however, that the more essential practical results of the explorations have been sufficiently well worked out to warrant placing them before the public in this preliminary paper. The fishes, which comprise the most important group of animals from an economic standpoint, have been placed in the hands of Prof. Charles H. Gilbert, of the Leland Stanford Junior University, who also accompanied the *Albatross* on several trips, and while a number of papers descriptive of the new species secured have been published by him, a discussion of the ichthyological results must be deferred until the completion of his final reports. Much progress has also been made in the working up of the crustaceans and mollusks, which next to the fishes offer the most forms of commercial value.

It has been the practice of the Fish Commission to transmit to the U. S. Coast and Geodetic Survey and the Hydrographic Office of the Navy all of the hydrographic data obtained by the *Albatross* at the end of each cruise. This information has been incorporated from time to time in the charts issued by those bureaus, and, as their publications can readily be obtained at all of the principal ports of the United States, it has not been considered expedient for the Fish Commission to duplicate this work. A few charts have, however, been published by the Commission for early distribution among the fishermen, and those relating to the Alaskan fishing-grounds are still the most desirable for the regions covered, being upon a larger scale and containing more details than any others. The five small maps which accompany this paper are intended mainly to show the positions of the principal fishing-grounds; they illustrate only a very small proportion of the work accomplished.

At the end of the paper is given a list of the publications of the Fish Commission, the U. S. Coast and Geodetic Survey, and the Hydrographic Office of the Navy, which relate directly to the investigations of the *Albatross*, or contain data derived from them, and may be regarded as supplementing the information given in this summary. The titles of a few earlier papers by the Fish Commission are also cited because of their important bearing upon the questions here discussed. The charts of the Coast Survey and Fish Commission will be found most useful by the fishermen, those of the Hydrographic Office covering the coasts of the United States being usually upon a small scale. Where referred to in the body of the paper they are designated by the numbers which accompany them. It should be understood, however, that this list is very far from complete as regards the literature which now exists relative to the fishes of the North Pacific Ocean, and many published papers respecting the scientific results of the *Albatross* are here omitted, as they do not immediately concern the question of the practical fisheries.

The explorations which the *Albatross* has been conducting on the Pacific coast, and which it is intended shall be continued to the extent of making known at least all the more important fishery resources of that region within the limits of the United States, are especially noteworthy from the fact that they constitute an innovation in the support given by government to the development of this particular industry. No foreign nation has ever attempted, on more than a very limited scale, to enlighten the fishermen respecting the character, distribution, and abundance along its coasts of the aquatic forms of life which are the objects of their pursuit. The United States was the first to institute systematic inquiries of this nature, in connection with the work of the Fish Commission along the Atlantic coast, and, although the fisheries had been carried on there assiduously for several centuries, the value of scientific research in extending the areas of productive fishing-grounds was conclusively established. In the new field presented by the North Pacific Ocean, however, so little information had previously been collected that it was necessary to begin at the very rudiments of the problem, as explained before, and the investigations have been of the most searching and comprehensive character.

The conduct of these inquiries have been in charge of Commander Z. L. Tanner, U. S. N., the commanding officer of the *Albatross*, whose long connection with the Fish Commission especially qualified him for this important task. Having been closely identified with all of the oceanic work since 1879, and thoroughly appreciating the objects to be attained, his services have been invaluable. In the hydrographic and physical observations he has had the assistance of the naval officers detailed to the ship. On the voyage from Norfolk to San Francisco, the civilian scientific staff consisted of Prof. Leslie A. Lee, of Bowdoin College (in charge), Mr. Charles H. Townsend, Mr. Thomas Lee, and Mr. Dennis M. Cole. Since that time, however, Mr. Charles H. Townsend has acted as resident naturalist, Mr. A. B. Alexander as fishery expert, and Mr. N. B. Miller as assistant naturalist. Prof. Charles H. Gilbert, now of the Leland Stanford Junior University, also accompanied the *Albatross*, as ichthyologist and chief naturalist, from January to August, 1889, and during the Bering Sea cruise of 1890.

The movements of the Albatross.—Leaving Norfolk, Va., on November 21, 1887, the *Albatross* began the voyage to San Francisco, which terminated on May 11, 1888. Agreeably to the plans proposed by Prof. Baird before his death, the commanding officer was directed to make occasional dredgings and hydrographic examinations on the way, and to afford such opportunities as time permitted for studying the local fisheries and other matters of scientific interest at each port of call, as well as at the Galapagos Islands off the coast of Ecuador. On the Atlantic side stops were made at Santa Lucia, one of the West Indies, Bahia, Brazil, and Montevideo, Uruguay. Scientific observations were conducted at frequent intervals during the passage through the Strait of Magellan, and the ship proceeded thence to Lota, Chile, and Panama. From the latter place the Galapagos Islands were visited, and subsequently Guaymas and La Paz, Mexico.

Having perfected the arrangements for a northern cruise, the *Albatross* sailed from San Francisco on July 4, 1888, for the Alaskan coast, where, during two months, the fishing-banks south of the Alaska Peninsula and adjacent islands, between Unalaska and Middleton Island, were made the subject of careful study. The balance of this season was spent on the coasts of Washington and Oregon. The local fisheries in the neighborhood of Seattle were investigated during the early part of

September, after which the survey was carried down the outer coast from Barclay Sound, Vancouver Island, and the halibut bank off Cape Flattery, to the vicinity of Tillamook Rock, just south of the Columbia River. The ship reached San Francisco from this cruise on October 21.

After refitting at this place, the months of January and February, 1889, were spent on the coast of California between Point Conception and the Mexican boundary line, the investigations being carried seaward to include all of the outlying islands, as well as Cortes and Tanner banks, the latter bank having been discovered by the *Albatross* during this trip. A line of hydrographic stations was then run to Guadeloupe Island, the Alijos Rocks, and the Revillagigedo Islands, after which a series of examinations was conducted through the Gulf of California as far as the mouth of the Colorado River at its upper end. This last inquiry was undertaken for the purpose of ascertaining the relations of the Colorado River to the waters of the Gulf, and observations were also made upon the oyster deposits of the region, which, it was conjectured, might afford a source of seed in the event of oyster-cultural operations being started in southern California. Starting from La Paz on April 7, several stops were made along the outer coast of Lower California, the *Albatross* returning to San Francisco on the 27th of the same month, but leaving there again on May 21 to resume the work off Washington and Oregon, which was continued until July 1, 1889.

From July 8 until July 28, 1889, the ship was used by the U. S. Senate Committee on Indian Affairs for the purpose of visiting the Indian settlements in southeastern Alaska. Subsequently the investigations were again taken up on the coast of Oregon and were carried southward, terminating October 14 at Cape Mendocino, California. The coast of California, between Point Arena and the Santa Barbara Islands, was examined during March and April, 1890, and on May 5 following the *Albatross* left San Francisco for Alaska, where the summer was occupied in developing the fishing-grounds in the southeastern part of Bering Sea, and determining the western extension of the continental platform on which the Pribilof Islands are located. The hydrographic results obtained on this cruise were of more than usual interest. During the trip south in the fall, some additional observations were made on the fishing-banks off the southern side of the Alaska Peninsula, a line of deep-sea soundings was run in the direction of the Queen Charlotte Islands, and the survey of the continental platform was completed from Cape Mendocino to Point Arena, California.

On January 30, 1891, the *Albatross* sailed from San Francisco on a special expedition, authorized by the President of the United States, to investigate the hydrographic and biological features over an extensive area off the western coast of Mexico, Central and South America, between Lower California and the latitude of the Galapagos Islands. Mr. Alexander Agassiz, director of the Museum of Comparative Zoölogy of Harvard University, was in charge of the scientific work, which yielded results of great importance. The cruise terminated the last of April.

During the summer of 1891, the *Albatross* was employed to convey the United States seal commissioners, Dr. T. C. Mendenhall and Dr. C. Hart Merriam, to Bering Sea. During the following fall and winter she was engaged in surveying for the cable route between California and the Hawaiian Islands, under the direction of the Secretary of the Navy. Again during the late spring and summer of 1892 she was detailed to participate in the sealing investigations in the North Pacific Ocean and Bering Sea, taking an active part in the extensive inquiries directed from the State Department.

BERING SEA.

PRELIMINARY REMARKS.

Itinerary of the investigations.—The general survey of Bering Sea by the *Albatross* was conducted during the summer of 1890, but in 1888, while engaged in a study of the fishing-grounds south of the Alaska Peninsula, a few observations were made in Iliuliuk Harbor and in the passes between Unalaska Island and Unimak Island, and during the summers of 1891 and 1892 some additional inquiries were also prosecuted in connection with the sealing investigations.

The principal object of the cruise of 1890 was to determine the positions and characteristics of the more important cod-fishing grounds, but the examinations were extended over the entire southeastern part of Bering Sea to a line some distance beyond the submerged continental border. The *Albatross* entered Bering Sea by way of Unimak Pass in the latter part of May, and carried a line of soundings in a northerly and easterly direction, a distance of about 80 miles, when stormy weather made it necessary to proceed to Unalaska, the soundings and dredgings being continued on the way. Leaving the latter place on May 28, the ship began a reconnoissance of the shore line of Bristol Bay, which was extended first along the north side of the Alaska Peninsula to Kvichak River, and thence to Kuskokwim River. From Cape Newenham a line of stations was run in the direction of the Northwest Cape of Unimak.

On June 23 investigations were commenced on Slime Bank, and were carried thence over Baird Bank to the head of Bristol Bay and the Kulukak ground. Two visits were paid to Port Moller and Herendeen Bay, where a coal mine had recently been opened, and partial surveys of both of those inlets were made, which define their entrance and the channel leading to Coal Harbor. During the first part of August a line of soundings was run from off Cape Cheerful, Unalaska, to Bogosloff Island, from the latter place in a westerly and northerly direction, and subsequently in a southerly direction, for the purpose of developing the 100-fathom curve along the western edge of the broad plateau occupying the eastern part of Bering Sea. The remainder of the season was spent in the vicinity of Unalaska, mainly in determining the resources of the fishing-grounds lying off the northern side of that island. The *Albatross* left Bering Sea for the south on August 25.

General features of the region examined.—The entire eastern and northern part of Bering Sea is occupied by a broad extension of the continental platform, which, for convenience of definition, may be said to terminate abruptly at a depth of about 100 fathoms. On the Siberian side the position of the 100-fathom curve is still undetermined, and previous to 1890 no observations had been made respecting the topography of the intervening deeper area, except in the immediate vicinity of the Aleutian chain of islands, where an important line of soundings was run by the U. S. S. *Tuscarora* in 1874.

On the eastern side of Bering Sea the 100-fathom curve extends from off the northern entrance to Unimak Pass in the direction of Cape Navarin, Siberia, forming a sinuous line approximately parallel with the coast line of the Alaskan mainland to the east, from which it is distant from 260 to 325 miles. The location of this curve, and therefore of the western border of the platform (as yet only approximately defined in most places), was largely established through the investigations of the *Albatross* in

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NOTE.—All bearings are true unless otherwise stated.

1890, the observations being carried by that vessel to 58° 43′ N. latitude, or about 168 miles northwesterly from St. Paul Island of the Pribilof group. From this point, in 144 fathoms, a line of soundings was run southward in the direction of Atka Island, developing a least depth of 977 fathoms and a maximum depth of 2,147 fathoms. A second line, farther to the eastward, extending from latitude 56° 12′ N., longitude 172° 07′ W., toward Uliaga Island, immediately to the west of Umnak Island, shows depths of 1,033 to 1,818 fathoms. Additional deep-sea soundings were made by the *Albatross* to the north of Unalaska Island, and several dredging stations were also occupied in depths between 100 and 1,625 fathoms. In the deeper waters the bottom was composed principally of green ooze, the absence of foraminifera, according to Capt. Tanner, being a marked feature of this region.

The location of the Pribilof Islands near the outer edge of this platform, with the interesting problems respecting the habits of the fur seals suggested by the controversy now in progress, makes it very important that the physical and biological features of the surrounding area should be thoroughly studied; but, although some progress in this direction has already been made, it is not intended to touch upon the subject in this connection, the remarks which follow having reference chiefly to the fishing-grounds for cod and halibut.

The fishing-banks investigated by the *Albatross* in 1890 are mostly situated to the eastward of a line connecting Cape Newenham with the northwest cape of Unimak and off the northern side of Unalaska Island, no extensive cod banks having yet been recorded from outside of these limits in the eastern part of Bering Sea. Capt. Tanner has extended the application of the name Bristol Bay so as to cover all of that region first defined above, but, as generally accepted by geographers, it is restricted to the much smaller area bounded on the north, east, and south by the mainland of Alaska, and not extending farther westward than an imaginary line drawn from Cape Newenham to Cape Seniavin on the peninsula, or to the neighborhood of Port Moller.

In the region occupied by these fishing-grounds the depths seldom exceed 50 fathoms, and the bottom is, for the most part, quite uniform in character, consisting mainly of fine sand, occasionally of coarse sand, and often having an admixture of gravel or pebbles. Cod were found to be quite generally distributed over this area, but the examinations were not sufficiently complete to define the outlines of the individual grounds in all particulars. Three separate banks have been recognized by Capt. Tanner—Slime Bank and Baird Bank, skirting the northern side of Unimak Island and the Alaska Peninsula, and Kulukak ground in the northern part of Bristol Bay; but from the information now at hand it can not be affirmed that these banks are entirely distinct and separate from one another. Slime Bank begins at the northern entrance to Unimak Pass. Its western end is more or less defined by the adjacent deep water which occurs in that locality, and its northern margin is limited to some extent by a muddy bottom. The somewhat barren ground which surrounds Amak Island also serves to break its continuity with Baird Bank, which, however, possesses the same character of bottom, and may be connected with it to the north of Amak Island. The latter bank extends northward as far as Cape Chichagof, and while the practical fishing operations which have been conducted upon it have been chiefly limited to within a comparatively short distance of the land, it is apparently connected with the Kulukak ground off the Walrus Islands, the intermediate bottom not differing essentially in its characteristics and being rich in cod.

All of Bristol Bay, except near the mouths of rivers and in certain other localities to be defined hereafter, is, therefore, practically a continuous fishing-ground, but further investigations are required to determine its extension westward, the area of good fishing being probably larger than is indicated by the present surveys. The combined length of Slime and Baird banks, from the Northwest Cape of Unimak to Cape Chichagof, is about 340 miles, and their total extent within the limits by which they have so far been defined is about 10,645 square miles. These banks, therefore, together with the remaining area within the boundaries of Bristol Bay, where cod and halibut occur, constitute one of the very largest fishing-grounds in either the Atlantic or Pacific Ocean, being exceeded, in fact, only by the Grand Bank of Newfoundland.

On this Bering Sea ground, however, the halibut seem to be mostly of small size, and it is chiefly important for its cod. It has been resorted to during a number of years past by one or more fishing vessels every season, but it remains for the future to fully appreciate and utilize its resources.

The weather in this part of Bering Sea, according to Capt. Tanner, is usually pleasanter than to the south of the peninsula. The principal grounds, moreover, have a weather shore with the prevailing summer winds, and a well-found vessel may anchor anywhere and ride out the usual gales at that season without much risk or discomfort.

Preliminary to the fishery investigations, and as a basis for the hydrographic work, a partial reconnoissance of the coast was made from Unimak Island to the head of Bristol Bay, and thence to Cape Newenham. This survey was rendered necessary by the fact that little dependence could be placed upon the existing charts with respect to the shore features, which have thus been referred to by Capt. Tanner:

> The shore lines are usually low and without distinctive features, but high mountain ranges and volcanic cones extend along the central parts of Unimak and the Alaskan Peninsula. These rugged, snow-covered mountains and lofty peaks would serve as unmistakable landmarks were they not obscured by the almost constant fogs which prevail in that region during the summer months. In fact, they were so seldom visible during the season of 1890 that the officers of the *Albatross* made no pretense of using them as landmarks. The shore line and objects near the sea level were often seen beneath the fog when the higher lands were obscured, and, therefore, most of the available landmarks were found on or near the beach.

Partial surveys were also made of Port Moller and Herendeen Bay, and of the lower part of Nushagak River.

FISHING-GROUNDS NORTHEAST OF UNIMAK PASS.

Slime Bank.—Slime Bank is the first of the larger fishing-grounds to be reached after entering Bering Sea through Unimak Pass. As delineated by the steamer *Albatross*, it begins directly off the Northwest Cape of Unimak Island, is elongate in shape, and follows approximately the trend of the adjacent coast to within a few miles of Amak Island, its inner margin lying only a short distance off the land. It is about 85 miles in length and 17 miles in average width, broadening somewhat at the eastern end; its total area is estimated at about 1,445 square miles. The depths range from 20 to 50 fathoms, while the bottom consists generally of black sand and gravel, frequently intermingled with pebbles, and sometimes of gray and yellow sand, rocks also occurring near the shore.

At its western end the bank is bordered by the deeper water lying off the northern entrance to Unimak Pass, 70 fathoms being found near the margin of the bank, and depths exceeding 100 fathoms a short distance farther away. Off its northern edge the depths determined by four soundings range from 53 to 62 fathoms, with muddy bottom at three of them. Toward the eastern end, however, on the northern side, sand and gravel occur, and in this locality the precise limits of the bank are still undefined.

This bank derives its name from the presence of immense numbers of a large jelly-fish, brownish or rusty in color, measuring from 6 to 18 inches across the disk, and provided with long, slender tentacles, having great stinging powers. These animals, it is said, have never been observed upon the surface of the sea, but seem to occupy an intermediate zone toward the bottom, where they occasion much annoyance to the fishermen by becoming entangled about their fishing gear, and in this way often being hauled up. It is also claimed that they sometimes interfere with the hooks reaching bottom, and by covering the bait and lines they render the former unattractive to the cod and the latter very uncomfortable to handle. Mr. Alexander states that up to the middle or latter part of June this so-called slime is not sufficiently abundant to give much trouble, but by July 1 it becomes so thick as to render it almost useless to remain upon the bank, and other localities, farther north, are then resorted to. Should the fishing be continued late, however, the fishermen profess to keep their hooks above the layer of slime, not allowing them to reach bottom.

After leaving the Akutan and Unimak grounds the fishermen anchor next on the western part of Slime Bank, gradually working to the eastward. The advantages for fishing on this bank, except for the unusual prevalence of jelly-fishes, are described as excellent, and cod are plentiful enough to supply all immediate demands. The largest and best cod taken by the *Albatross* were obtained some 6 or 8 miles from shore, those captured nearer land having been inferior in size and quality. From the results of this investigation and from information derived from other sources it would appear, however, that cod of fair size are pretty generally distributed over the bank, and are almost everywhere abundant.

The examinations by the *Albatross* were begun on June 24, 1890. Five beam-trawl stations (Nos. 3259–3262, 3264) were made on the western end of the bank, and three (Nos. 3265–3267) on the eastern end. The bottom fauna was found to be very rich, affording good feeding-ground for fishes.

Hand-line fishing was carried on at each of the dredging stations and also in connection with some of the soundings. Seven trials were made on the western part of the bank, from off the Northwest Cape to off Cape Lapin, in depths of 13 to 43 fathoms. The trials occupied from 10 to 15 minutes each and aggregated 96 minutes, from 9 to 12 lines being employed: The total number of fish taken was 132, ranging in length from 23 to 37 inches, the average size for each catch ranging from 26⅜ to 32½ inches. The combined weight of all the fish was 1,528 pounds, making their average weight about 11½ pounds apiece. One halibut, weighing 5 pounds, was also taken in this region, and in 62 fathoms, muddy bottom, just outside the bank, 7 cod were captured averaging 12 pounds in weight and 30¾ inches in length. Nineteen cod, averaging 27 inches in length, were secured in Shaw Bay, in a depth of 6 fathoms, sandy bottom, the trial lasting one hour.

Five trials, with 8 to 10 hand lines and aggregating 79 minutes, were made at the eastern end of the bank in depths of 26 to 44 fathoms. The catch amounted to 53 cod, ranging in size from 20½ to 36 inches, and in average size for each trial from 24⅜ to 31½ inches. Their aggregate weight was 574 pounds, an average of about 10⅘ pounds each. One halibut, weighing 8 pounds, was also taken in 32 fathoms.

A few attempts have been made to employ cod trawls on Slime Bank, but they were not attended with satisfactory results, as the jelly-fishes interpose too great an obstacle to this kind of fishing. This bank, moreover, is otherwise better suited to the use of hand lines, on account of the shallow water and the abundant supply of fish. There are no available harbors along the adjacent coast, although excellent protection may be found in Shaw Bay during southeast to southwest winds. Winter fishing would, therefore, be attended with much danger from the heavy storms which then prevail, and the season is chiefly limited to the summer months, when only occasional moderate blows occur. It is the opinion of Captain Tanner that a well-found fishing schooner could anchor anywhere on Slime Bank between May and September, with an even chance of being able to ride out any gale she would encounter.

Amak Island.—Amak Island lies about 11 miles off Izenbek Bay, and, as indicated by the dredging work, seems to be surrounded by a comparatively barren region, some 18 to 20 miles in width, which may be regarded as separating Slime Bank from Baird Bank. How far seaward these conditions hold was not determined, as all of the dredging and fishing stations were within a short distance of the island. Beam trawling was carried on in five different positions (stations Nos. 3269–3272), but with poor results, the bottom fauna being far from rich.

Nine trials were made with hand lines in depths of 10 to 35 fathoms. Two of these proved entirely unsuccessful, while at the remainder the total catch amounted to 33 cod, weighing only 260 pounds, an average weight of about 7.9 pounds apiece. The average length for the several trials ranged from 23 to 29⅔ inches. So far as the evidence goes, therefore, fish are less abundant and of smaller size in this region than on the adjacent banks. This may be due in part to the presence of numerous sea lions, which haul out upon Amak Island, Sea Lion Rocks, and the neighboring coast, but it is probable that some other cause must also be held accountable for this condition of affairs, especially as regards the scarcity of invertebrates and the relatively smaller size of the cod. Walruses are likewise plentiful in this region, but they are not fish-feeders.

Amak Island affords fairly good protection on its southeast and southwest sides, and can easily be reached from the contiguous parts of both Slime and Baird banks.

Baird Bank.—Baird Bank, generally known to the fishermen, in part at least, as Port Moller bank or ground, was named by Capt. Tanner in honor of the late Prof. Spencer F. Baird, the first U. S. Commissioner of Fish and Fisheries. It is the largest of the fishing-grounds yet discovered on the Alaskan coast. As described and charted by Capt. Tanner, it commences a few miles east of Amak Island and extends northeastward, off the northern side of the Alaska Peninsula, to the vicinity of Cape Chichagof, at the mouth of the Ugaguk River, a distance of about 230 miles. It has an average width of about 40 miles and an extreme width of 58 miles, its total area being estimated at about 9,200 square miles, which is 2,400 miles more than that of Portlock Bank, off Kadiak Island, and some 800 miles more than that of Georges Bank, in the North Atlantic Ocean.

It is doubtful, however, if the limits of this bank should be so restricted, as several lines of stations connecting it with Kulukak ground and the region off Cape Peirce show the extension in that direction of essentially the same depths of water and character of bottom, good fishing also having been obtained at nearly every trial. This would make of Bristol Bay in its restricted sense (inside of a line drawn from Cape Newenham to Cape Seniavin) a practically continuous fishing-ground, except at the mouths of the larger rivers and in some other places as explained below. Outside of Bristol Bay the observations were not carried beyond the limits of the bank as defined by Capt. Tanner, and the entire width of its western portion still remains to be determined. It is not impossible that some connection may be found to exist between Baird and Slime banks to the north of Amak Island. A line of stations from Cape Newenham to the Northwest Cape of Unimak Island, however, showed good fishing only in the vicinity of land.

The examination of Baird Bank was begun at the western or southern end of the bank on June 27. The soundings were generally conducted along regular lines, approximately at right angles to the coast, but to the west of Cape Seniavin they were not carried beyond a maximum distance of about 48 miles from land. Inside of this point, however, they were run practically from shore to shore. Thirty-two dredging stations (Nos. 3235–3238, 3273–3299, and 3303) were occupied within the limits of Baird Bank as originally defined; 4 stations (Nos. 3288–3290, 3295) between the bank and the shores of the peninsula; 7 stations (Nos. 3228–3234) at the extreme head of the bay, in the broad mouth of the Kvichak River; and 14 stations (Nos. 3239–3246, 3300–3302, 3304–3306) between the bank and the northern shores of Bristol Bay. Fishing trials with hand lines were made at all dredging stations and at the majority of sounding stations.

The inner margin of Baird Bank has been made to correspond approximately with the 15-fathom line. A maximum depth of 53 fathoms was discovered about 37 miles off Lagoon Point, to the westward of Port Moller. West of Cape Seniavin, however, the depths range mostly from 30 to 45 fathoms, while to the eastward of that point they gradually diminish toward the head of Bristol Bay, the soundings at the extreme end of the bank in that direction indicating depths of 11 to 20 fathoms. In the direction of Kulukak Bay and Cape Peirce the depths also decrease gradually, becoming reduced to 15 and 17 fathoms on the Kulukak ground. The bottom consists mainly of fine gray sand, with areas of black sand, black sand and gravel, and occasionally rocky patches near the shores. The bottom fauna over the main part of the bank was discovered to be rich and varied, in most places corresponding with that of Slime Bank.

According to Capt. Tanner, the conditions improved with each line of stations until off Port Moller, where the most productive fishing-ground was found. Cod were taken on nearly every trial with the hand lines, but their abundance and quality varied in different localities. They were smaller and in poorer condition near the land, the best results having been obtained some 15 to 20 miles offshore, in depths of 25 to 40 fathoms. In shallow water the bottom was often covered with sponges, mussels, and large clustered barnacles adhering to the rocks, the cutting edges of the latter soon tearing the nets to pieces.

The results of hand-line fishing may be summarized as follows, with respect to the general grouping of the stations on the bank:

Two trials only were made at the extreme southwestern end of the bank, in depths of 26 and 39 fathoms, respectively, the catch consisting of 9 cod, having an average weight of about 10 pounds and an average length of about 27 inches. A few pollock and sculpins were also taken at the same time.

Off Lagoon Point, in an area covering a length of about 25 miles and extending 48 miles from land, 13 trials were made in depths of 18 to 53 fathoms. The total catch amounted to 56 cod, an average of 4⅓ to each trial, the average length of the trials having been 14 minutes. The average weight of the fish was 9¼ pounds and their average length 27⅛ inches. In some places, however, a large proportion of the fish ranged from 28 to 35 inches in length.

Three trials were located directly off Port Moller, at distances of 16 to 33 miles from land, in depths of 25 to 39 fathoms. At these stations 65 cod were obtained during an aggregate period of 60 minutes, the average weight of the fish being 13 pounds and their average length about 30¾ inches; the range in length was from 19 to 39 inches.

Off Cape Seniavin, within an area 23 miles long, extending 44 miles from shore, 9 trials, averaging about 30 minutes each, yielded 102 cod, or an average of 11⅓ to a trial. The average weight of the fish was 10⅖ pounds, their average length 29⅕ inches, and their range in length from 20 to 36 inches. The average length of the trials was much increased in this region by the fact that at one of the stations, about 12 miles off the cape, fishing was continued for 2½ hours. Forty-one cod were taken at this station in a depth of 20 fathoms, and 33 cod about 23 miles farther to the eastward, in 30 fathoms.

Another important group of stations occurs off Port Haiden and between there and Cape Menchikof, covering a length of 28 miles and a width of 67 miles from shore. Eleven trials were made, averaging 14½ minutes in length, the total catch amounting to 210 fish, an average of about 19½ fish to a trial. The average weight was 10⁶⁄₇ pounds, the range in length from 18 to 36 inches, and the average length 29⅔ inches.

From off Cape Menchikof to the northern extremity of the bank, a distance of some 40 miles, seven trials were made in depths of 11 to 24 fathoms, the average duration of each trial having been about 13½ minutes. The total catch was 75 cod, an average of about 10⅔ to each trial. The average weight of the fish was 12 pounds, their range in length from 26 to 34 inches, and their average length 30⅖ inches.

A comparison of the results obtained at each of the groups of stations above discussed furnishes some interesting facts respecting the value as fishing-grounds of different parts of Baird Bank, but they are not to be considered as entirely conclusive, owing to the relatively short duration of the fishing trials. For many reasons, however, such a comparison is important, especially as directing the attention of the fishermen to localities which they have not visited.

The relative abundance of the cod in the different areas may be expressed by the proportion of fish to the length of time occupied in making the trials, which, reduced to minutes, shows that the best results in this respect were obtained off Port Haiden, the remaining areas coming in the following order: North of Cape Menchikof, off Port Moller, off Cape Seniavin, and off Lagoon Point. A comparison of the groups of stations with reference to the average weight and the average length of the cod necessitates a somewhat different arrangement from that above given, the area off Port Moller (13 pounds, 30¾ inches) taking precedence, followed by "north of Cape Menchikof" (12 pounds, 30⅖ inches), "off Port Haiden" (10⁶⁄₇ pounds, 29⅔ inches), "off Cape Seniavin" (10⅖ pounds, 29⅕ inches), "off Lagoon Point" (9¼ pounds, 27⅛ inches).

Many additional observations are required, however, before passing finally upon the relative values of the different parts of the bank, and this is all the more evident when it is considered that the examinations by the *Albatross* were restricted to a very brief period during one summer. The distribution of cod, moreover, is greatly influenced during some seasons by the movements of certain migratory fishes which they seek as food, such as the capelin, herring, and sand lance, but at present scarcely anything is known regarding the habits of these species on the Alaskan coast. The fishermen consider that good fares are most certain to be obtained off Port Moller, although successful trips have been made farther north.

During the progress of the investigations, the schooner *Vanderbilt*, of San Francisco, Capt. A. W. Smith, was observed at anchor on the Port Moller ground, about 20 miles offshore, where she had been a little over a month. Owing to the excellent fishing obtained, only a single berth had been made. About 43,000 cod had been taken up to the time of the visit of the *Albatross*, and the trip was subsequently completed with a fare of about 48,500 count fish, each measuring 28 inches and over, and several thousand small fish. Capt. Smith regards the Port Moller ground as superior to any other in Bering Sea, not that the fish are larger or of better quality than on Slime Bank, but the bottom is cleaner and jelly-fishes are not troublesome. He states that halibut weighing about 25 pounds are seldom taken, but individuals of smaller size are abundant during some seasons, and when obtained are used as bait. During the past season they had been scarce. From June 11 to 21, 1890, heavy winds prevailed and prevented fishing. Stormy weather seems to scatter or drive the cod from the fishing-spots, and at such times it is thought they seek deeper water.

Between the inner edge of Baird Bank and the adjacent mainland eight trials were made with hand lines in depths of 8½ to 16 fathoms, but cod were taken at only three of them. The total number so captured was 19; 4 near Nelson Lagoon, measuring from 28 to 32 inches; 10 off Port Moller, measuring from 26 to 32 inches; and 5 near Port Haiden, measuring from 28 to 33 inches.

The good fishing-spots found at the extreme northern end of Baird Bank are located a short distance outside of the extensive shoals surrounding Cape Constantine, but the head of Bristol Bay, to the northward of a line drawn from the mouth of the Ugaguk River to Cape Constantine, has no value as a codfishing-ground, and only a few fish, in poor condition, were captured here and there. The water is not only too fresh for this species, but, owing to the strong currents produced by the immense discharge from several rivers and by the tides, an unusual amount of sand and mud is constantly held in suspension. An examination of the stomachs of those captured showed that they had been feeding upon salmon, and they had evidently been attracted to these unsuitable waters by the presence of the latter fish. Farther south, on the same bank, their food embraced a great variety of bottom life, such as crustaceans of several species, holothurians, starfishes, ophiurans, sea-anemones, and other forms of invertebrates, as well as fishes. Small pebbles and even stones of relatively large size were not infrequently found in their stomachs, as has so often been recorded in connection with the fishing-banks of the North Atlantic, but their presence may readily be explained by the fact that the sea-anemones and some other animals used as food by the cod grow firmly attached to such objects, which would naturally be swallowed with them.

The conditions of weather on Baird Bank are practically the same as on Slime Bank. The adjacent peninsula affords a weather shore during southeast winds. Port Moller and Herendeen Bay will be resorted to when they are better known, and Port Haiden may also become available for shelter after it has been surveyed. According to Mr. Alexander, southerly and westerly winds cause no inconvenience on the bank, but a strong breeze from the northwest or southwest is immediately followed by a disagreeable choppy sea.

Four lines of stations were run from the outer margin of Baird Bank as defined by Capt. Tanner, in the direction of the northern coast of Bristol Bay, which show that the bank should probably be extended as far as the shoaler water of Kulukak Bay and off Cape Peirce. On the westernmost line, reaching a distance of about 70 miles, 5 trials were made in depths of 23 to 33 fathoms, the catch consisting of 25 cod, measuring from 23 to 33 inches. On the second line, extending about 58 miles, with depths of 22 to 31 fathoms, the number of trials was 4, the total number of cod 30, measuring from 26 to 36 inches. The two eastern lines were both much shorter and connected Baird Bank with Kulukak ground, as described farther on. Five trials were made in depths of 15 to 30 fathoms, resulting in the capture of 46 cod, measuring from 21 to 34 inches. The better portions of Kulukak ground are included in this area. The size of the fish varied considerably in different parts of the region, but without reference to the depth of water or character of bottom. The general results may be summarized as follows: Aggregate time consumed in making the trials 230 minutes, total number of cod taken 101, average weight of the cod 10⅗ pounds, average length 29⅓ inches. These results correspond approximately with those obtained off Cape Seniavin and off Port Haiden, but the extent of the area is too great to make such general deductions and comparisons of much value. Good and profitable fishing could, however, undoubtedly be found in some places.

Kulukak Bay.—Kulukak Bay occupies a large part of the region included between Cape Constantine and Cape Newenham, and contains Hagemeister Island and the Walrus group. Within this area codfish are found in isolated spots, scarcely entitled to the name of banks, but for convenience sake the title of Kulukak ground has been used by Capt. Tanner to designate them. Extensive shoals occur off Hagemeister and the Walrus islands, 6 fathoms being found about 15 miles to the southward of the latter. The principal fishing-spots are outside of these shoals, as well as to the eastward and westward of them, in depths of 12 to 25 fathoms, the bottom consisting generally of sand, with some mud and gravel, and the fauna being essentially the same as on Baird and Slime banks. These outer grounds have already been referred to under the heading of Baird Bank. They were formerly resorted to at times by fishing vessels, but they are said not to be at present.

The fishermen have called attention to a small ground, called Gravel Bank, situated about 16 miles SSW. from the southern end of Hagemeister Island, where large cod are reported to be abundant. It has depths of 16 to 20 fathoms, but its size is inconsiderable. It is stated that small fish predominate among the islands of the Walrus group, but that larger ones may be taken in some of the indentations and on some of the rocky patches, although such places are not numerous. Between these islands and the mainland the bottom was found by the *Albatross* to be exceedingly barren, black mud being frequently encountered.

Out of 7 trials made near the shore between Cape Constantine and Cape Peirce, cod were captured only twice. One specimen, weighing 17 pounds, was secured in 11¼ fathoms about 18 miles west of Cape Constantine, while 8 specimens, averaging 13 pounds in weight and 33¼ inches in length, were taken off the east side of Walrus Island.

Cod are said to be abundant in the neighborhood of Cape Peirce, but none were taken by the *Albatross* in the immediate vicinity of either Cape Peirce or Cape Newenham. Eleven miles southwesterly from the latter cape 2 specimens were obtained, measuring 29 and 32 inches respectively, and 22 miles farther in the same direction a total catch of 15 cod was made, but their average size was only 27⅜ inches.

The examinations of the *Albatross* were not carried north of Cape Newenham, but cod are reported to occur in greater or less numbers as far north as the ice line; but how extensive the banks or how profitable the fishing may be in this region can only be ascertained by a detailed and careful examination.

Condition of the cod in Bering Sea.—Attempts have been made to compare the abundance, size, and condition of the cod inhabiting Bering Sea with those taken on the fishing-grounds in the North Atlantic Ocean, but up to the present time sufficient data have not been obtained to justify conclusions in this respect. The trials made by the *Albatross* have all been of short duration, very rarely exceeding 20 minutes, and in the majority of cases not more than 15 minutes. At the same time, moreover, the ship was generally drifting with the wind and current, the hooks being thereby dragged along over the bottom. The fishermen consider that a berth has usually to be occupied for some time before the best fishing begins or the larger fish appear in the greatest numbers. It is recorded as the experience of fishing vessels on Baird Bank that better results are obtained after the lapse of two or three days than when first anchoring, and the supply has tended to increase rather than diminish by the end of a week. The bait which falls from the hooks or otherwise reaches the bottom probably serves to tole the fish about the spot, and thus contributes to their greater abundance.

The total number of trials made by the *Albatross* with hand lines in Bristol Bay was 110, and the aggregate amount of time spent in this work was 1,907 minutes, an average of about 17 minutes to each trial. Two of the trials, however, were long ones, occupying 2½ and 3 hours, respectively. If these be deducted it reduces the aggregate time to 1,540 minutes, and the average time to between 13 and 14 minutes. The total number of cod taken during these trials was 922, an average of 8⅓ fish to a trial. From 8 to 12 lines were generally employed.

Limiting the calculations to what have been designated above as the banks proper in Bristol Bay, we find that the total number of trials was 74, the aggregate time 1,374 minutes (including one trial of 2½ hours), and the average time 18½ minutes. A total of 832 cod were captured on these trials, being an average of 11 fish to each trial.

All of the cod secured were weighed and measured, and the average of weight and length was calculated for each trial. The smallest fish measured 9 inches, the largest 39 inches. In a number of trials, as before mentioned, nothing was obtained, and in some others only a few fish of small size were taken. At 75 stations, however, the average size ranged from 24 inches to 32½ inches, distributed as follows: 3 stations, 24 to 26 inches; 19 stations, 26 to 28 inches; 25 stations, 28 to 30 inches; 28 stations, 30 to 32½ inches. Considering all the circumstances attendant upon the trials, the results obtained by the *Albatross* must therefore be regarded as exceedingly favorable and indicative of an abundant supply of good, marketable fish.

The range in weight of the cod taken in Bristol Bay was from 2½ to 27½ pounds, the average weight about 10½ pounds. The highest average obtained at any one station was 15½ pounds, on Slime Bank; and the next highest 15⅓ pounds, on the Port Moller ground of Baird Bank. The average of several catches on these two banks reached 15 pounds, and it must therefore be considered that the run of fish is about the same on both.

A marked difference exists in the size and quality of the fish in different localities, as elsewhere explained, but after sufficient experience has been acquired a judicious discrimination in the choice of grounds will be possible, and the few fishing vessels which resort to this region already have their favorite spots, where they find no trouble in securing full fares. In any consideration of this general subject, however, it should be borne in mind that the only information on which to base conclusions has been obtained during a few summer months of each year, while the great banks on the Atlantic coast have been visited by multitudes of fishing vessels for several centuries.

Mr. Alexander reports a large proportion of diseased fish in the shallow water along the coasts, due in part at least to parasitism, but the proportion decreases as the water deepens, and at 8 or 10 miles from shore the average is very good. Capt. Tanner also refers to the occurrence of many wounded cod, particularly in the spring and fall, after the passage of the seals into and out of Bering Sea. They have been chiefly observed near the passes between the Aleutian Islands.

Halibut and flounders in Bristol Bay.—Only three specimens of halibut were taken by the *Albatross* within the limits of Bristol Bay, and they were all small, their combined weight amounting to only 42 pounds. As mentioned elsewhere, Capt. A. W. Smith, of the schooner *Vanderbilt*, informed Mr. Alexander that, according to his experience, halibut weighing above 25 pounds are seldom captured in this region, although individuals of smaller size are abundant during some seasons. He had also found them scarce during the season of 1890. The specimens taken by the fishing vessels are generally used as bait for the cod. Flounders of several species, some of which were of excellent food quality, were captured in the beam trawl at nearly every station.

Port Moller and Herendeen Bay.—From their proximity to the better fishing-grounds on Baird Bank, these two bays may be regarded as affording convenient shelter for fishing vessels during stormy weather. Hitherto they have seldom, if ever, been used for this purpose, owing to the lack of information respecting their hydrography, but this desideratum has been in part supplied through the agency of the *Albatross*. Their channels, however, have not yet been buoyed, nor are they likely to be for some time, and access to them must, for the present, be considered as rather difficult. Both bays are shallow and elongate, cutting more than halfway through the Alaska Peninsula and opening close together on its northern side, the principal passage into Herendeen Bay leading through Port Moller entrance. A detailed account of the survey made in 1890, together with sailing directions, will be found in Commander Tanner's reports (F. C. 9, pp. 281-283, and F. C. 10). The former contains a chart suitable for navigation purposes. It shows the entrance to Port Moller, the channel from Entrance Point to Point Divide, called Hague Channel, the narrow and intricate passageway from the latter point to Marble Point, named Johnston Channel, after the officer who surveyed it, and the general contour of the upper part of Herendeen Bay, including Mine Harbor, the headquarters and shipping station of the coal company.

According to Capt. Tanner, "the entrance to Port Moller is guarded by banks and shoals over which the tide sweeps with great force, making the channel difficult and dangerous, its ill repute having, in fact, caused the great bay and its tributaries to remain almost a *terra incognita* to the navigator." The survey of the *Albatross* will render these harbors available hereafter, but the chart should be used with caution until it is ascertained whether the banks about the entrance are permanent or shifting. There is an excellent beach at Mine Harbor for hauling a schooner out, if necessary. The rise and fall exceeds 15 feet, and would give several hours each tide to examine or make repairs on a vessel's bottom. Should the coal mine be developed, as seems probable, the place would afford some facilities for repairing and refitting; water is easily procured and fuel can be had in any quantity. There is no settlement at present on either bay.

The coal mine above referred to is situated about 1¼ miles from the water front, to the eastward of Mine Harbor, transportation to the landing being effected by means of a tramway operated by a small steam motor. The mine was opened just previous to the visit of the *Albatross*, which took the first output of coal. The latter was used with satisfactory results, but owing to the lack of proper screening facilities much fine material and dirt was delivered with it, and it was found necessary to burn from 20 to 25 per cent more in quantity to obtain the same results as with a fair quality of Wellington coal. For a full account of its steaming qualities, see report of Passed Assistant Engineer C. R. Roelker, U. S. Navy (F. C. 10, pp. 282, 283). Capt. Tanner states, however, that, "considering that it was taken from a vein near the surface, the extra amount required to furnish the same quantity of steam will not seem excessive. It was shown that the coal possesses merit, and it will doubtless improve with the development of the deeper veins."

Salmon fishery on the Nushagak River.—While the *Albatross* was anchored in the Nushagak River, at the head of Bristol Bay, many important facts respecting the salmon fishery and canning industry which has recently sprung up in that locality were obtained by Mr. Alexander, whose discussion of the subject is contained in the appendix to the report of the Fish Commission for 1889–1891. The following statements from this source relate mainly to matters of scientific interest:

The first salmon cannery on the Nushagak was built in 1884 by the Arctic Canning Company. Three similar establishments have been added since that time, all being located between the mouth of Wood River and Clark Point. The salmon first make their appearance about June 1, and remain from forty-five to sixty days. As the season is short, full preparations are made in advance and great activity prevails during the continuance of the run. The king salmon appear earliest and are present about a fortnight, being first sought for off Coffee Point, a high promontory situated on the west side of the river. They are followed by the red salmon, and the latter closely by the silver salmon. During the season of 1890 the first salmon were taken on the morning of June 3, after which several days elapsed before other fish were seen.

The presence of ice retards their movements; they will not enter the river until it has disappeared and the temperature of the water has moderated to some extent. When the salmon are late in arriving, they proceed immediately upstream to Lakes Nushagak and Aleknagik, where they spawn; but if the season is an open one, they move more leisurely, and furnish better opportunities for fishing. In the spring of 1890 the river was blockaded with ice until May 20, and the run was late in consequence. The fishermen believe that the salmon spawn about a month after entering the river, and the superintendent of the Bristol Bay Canning Company, who has had much experience in this region, states that from the first of August until October the young are passing down the river and into the sea in immense numbers.

It takes on an average six of the red salmon, and the same number of silver salmon, to make a case of the canned goods. Two and one-half of the king salmon are equivalent to the same amount.

Each cannery has hitherto maintained from one to five traps for capturing salmon, but the yield by this means has not warranted the expense of keeping them in repair. The main body of the trap is made of twine, but the leaders are constructed of galvanized wire netting, which is better adapted to withstand the pressure of drift material brought down by the current. Notwithstanding every precaution, however, they are frequently swept away. Gill nets have now been adopted by all the canneries, as affording the best results. Two sizes are in use. The one for king salmon measures 100 fathoms long by 23¾ feet deep, and has a 9½-inch mesh; the other, for red and silver salmon, is 70 fathoms long by 13 feet deep, and has a 6½-inch mesh. They seldom last more than a single season, as they are subject to very hard usage.

The salmon are sometimes most abundant a considerable distance above the canneries, or from 40 to 50 miles from the mouth of the river. At such times the fishermen are carried to the fishing-grounds, where they live on board of the scow lighters ordinarily employed for discharging and loading vessels, a steam launch being used to tow the latter.

Under instructions received from the Secretary of the Treasury, Capt. Tanner inspected the site of a proposed large fish-trap on Wood River, a tributary of the Nushagak River, which, it had been reported, would prove an obstruction to the movements of salmon within the intent of the law of Congress approved March 2, 1889. He found that a double trap was being built about 20 miles above the mouth of the river and 40 miles from the Nushagak cannery. The Wood River at this point is a swift running stream of clear, cold water, between 700 and 800 feet wide, and 10 to 14 feet deep. Operations had not progressed sufficiently to indicate the character and extent of the work, but the plans contemplated an opening in midstream 100 feet wide, flanked on each side by a trap 40 feet square, with wings extending from the traps to the shores. The Secretary of the Treasury has decided that such a construction would be illegal.

UNALASKA ISLAND AND VICINITY.

This island has been visited several times by the *Albatross* in the course of the Alaskan investigations, from 1888 to 1892, principally for the purpose of coaling or repairing, but much valuable information has been secured regarding the fishery resources of the contiguous waters and the hydrography of the neighboring region. On approaching the Aleutian Chain, at the beginning of the season of 1888, a line of soundings was carried inshore to a depth of 28 fathoms, off Kiliuliuk Bay, on the southern side of the island. Subsequently the *Albatross* proceeded into Bering Sea through Unimak Pass and entered Unalaska Harbor from the north, the return trip to the Pacific Ocean being made by way of Unalga Pass. The hydrographic observations obtained during these two passages, sailing directions, and a general account of the fishery resources and native industries of Unalaska Harbor have been published in the Bulletin for 1888 (F. C. 8, pp. 19-22) and in the appendix to the Commissioner's report for the same year (F. C. 7, pp. 397-400).

During the summer of 1890 a general reconnoissance was made of the submerged platform off the entire northern and western sides of the island. Akutan Pass was used by the *Albatross* on leaving Bering Sea, in August of the same year, the trip through being referred to by Capt. Tanner as follows:

> The atmosphere was usually clear, and as we had never used Akutan Pass we availed ourselves of the favorable opportunity of passing through and examining it. There is a clear channel two miles or more in width between Cape Morgan and four small islets lying off Unalga Island, free from dangers except near the shores, with 26 fathoms, rocky bottom, in the narrowest part of the pass.

Unalaska Harbor and adjacent waters.—During the summer of 1888 collecting was extensively carried on in this harbor and in the waters adjacent to it. Seining proved everywhere successful within the limits of the harbor, but the few hauls made at or near its mouth were unproductive, owing probably to the fact that the water there deepens rapidly from the shore outwards. The natives, however, take cod in these exposed positions. The *Oncorhynchus gorbuscha* (humpback salmon), *O. keta* (dog salmon), and *O. nerka* were seined abundantly both in the main harbor and in Captain Harbor at its head. The red-spotted trout (*Salvelinus malma*) was also plentiful in the harbor and in the fresh-water lake. Other common species obtained were the *Pleuronectes stellatus* (starry flounder), *Lepidopsetta bilineata*, *Hemilepidotus jordani*, and *Clupea mirabilis* (herring). The advantages offered by Unalaska for the establishment of fishing stations and the preparation of dried salmon or *ukali* by the natives have been discussed in the Fish Commission reports last referred to above.

The investigations were continued in Unalaska Harbor at intervals during the summer of 1890, and late in the season they were carried along the Bering Sea side of the island from Priest Rock, in the east, to Umnak Island, in the west. Regarding the vicinity of Unalaska Harbor, Mr. Alexander states that the fishing-grounds extend only a short distance from the shore, the width of bottom over which cod may be expected to occur ranging from 3 to 6 miles. The fishing-spots consist of rocky and muddy patches of variable extent, on which sand, gravel, and shells also occur in small quantities. The rocks are generally sharp and would prove destructive to fishing gear. Cod are frequently caught from the wharf and beach in Unalaska Harbor, and there are certain places in Captain Harbor where this species is sufficiently abundant to supply the local demands during the entire year. The fish taken in such localities, however, are inferior in quality to those captured farther off shore, but as salmon form the principal diet of the natives a large stock of cod is never secured at one time. The latter species is almost invariably eaten fresh, but small quantities may be dried in the same manner as the salmon.

According to Capt. Tanner:

> Rumor placed valuable cod banks in the outer bay, but no one seemed to know their exact locality or extent. Such a resource at the doors of a populous settlement would be of inestimable value. Availing ourselves of the opportunity offered by a clear day, we ran several lines of soundings across the bay, making frequent hauls of the trawl and trials with the fishing lines, extending the examination to the 100-fathom line outside of Cape Kalekhta, or Priest Point, and Cape Cheerful, without finding indications of even ordinarily good fishing-ground. In fact, nearly every sounding inside of the capes gave muddy bottom. Spots were discovered, however, near the shore line where cod were plentiful.

At a subsequent time "the search for cod banks in Unalaska Bay was resumed. The region from Ulakta Head to Elder Point was carefully examined, and the examination was extended to Broad and Nateekin Bays, without developing anything that could be called a fishing-bank. Near the shores, however, particularly on the west side of the bay, cod were plentiful and halibut were fairly abundant."

Pass and off the Northwest Cape of Unimak Island, near the western end of Slime Bank. In the spring they not infrequently obtain moderately good fishing off the islands of Akutan, Akun, Tigaldi, and Avatanak, between Unimak and Unalaska. These places compare favorably with the banks in Bristol Bay as to the size and quality of the cod, but, as the fish are much less abundant, full fares are not taken there. The natives, however, have no trouble in securing, about these islands, all the cod, flounders, etc., needed for their own use.

Trawl lines are not employed in Bering Sea, although they have been tried there, the depth of water and character of the bottom making it more convenient and profitable to resort to dory hand-line fishing.

Additional notes on the vessel fishery in Bering Sea will be found in the U. S. Fish Commission Bulletin for 1888, pages 22, 23.

Bait.—The vessels depend chiefly for their bait upon the fresh fish taken on the hooks during the progress of their fishing operations, and there is seldom any difficulty in obtaining all that is required for that purpose, and even much more. The fishes so employed, according to Mr. Alexander, consist principally of sculpins, flounders, halibut, when they can be secured, and several other small species. The small halibut are said to make an excellent bait, being second only to the squid in that respect. A small quantity of salt salmon and herring is usually taken along to serve for the first baitings.

Meteorological conditions.—Capt. Tanner summarizes as follows the observations made upon the wind and weather in Bering Sea from the last of May to September 1, 1890:

> Southwest winds prevailed, but we had them frequently from southeast to northwest. It was boisterous weather nearly half the time, but seldom rough enough to interfere with our work. We had several summer gales of moderate force, but no severe storms. Fog and mist prevailed, and a clear day was the rare exception. The tidal currents were strongest in the vicinity of Unimak Pass and at the head of the bay; they were greatly affected, however, by the winds. The flood stream set to the northward and slightly inshore along the coasts of Unimak and the peninsula, the ebb to the southward and offshore. The former was invariably the stronger, and probably found an outlet by sweeping past Cape Constantine in the direction of Cape Newenham. There has been no systematic study of the currents of Bering Sea, and the almost constant fogs prevent the navigator from adding much to our meager knowledge concerning them.

The daily meteorological observations for the same period have been published in the Fish Commission Report for 1890–91.

Bogoslof Island and Volcano.—On the afternoon of August 2, 1890, the *Albatross* passed within three-fourths of a mile of Bogoslof island and volcano, of both of which good photographs were obtained. The day was unusually clear, Makushin and the high lands of Umnak being distinctly visible. Regarding the observations made in this interesting locality, Capt. Tanner reports as follows:

> Sail Rock had fallen, its original position being marked by the débris. New Bogoslof was enveloped in smoke so dense that its outline could not be accurately determined, but its altitude was not far from 400 feet. There were no outlying dangers visible, and a couple of soundings, taken 2 miles from the old cone on different bearings, gave 649 and 578 fathoms, the latter being on the reef marked on old charts as extending from Bogoslof to the north end of Umnak. It is needless to say that this reef does not exist. Myriads of guillemots were seen on the island and for 15 miles or more around it, and a portion of the beach was occupied by a rookery of very large sea lions. Old Bogoslof is rapidly crumbling away, and will, like Sail Rock, eventually disappear.

WASHINGTON AND OREGON.

GENERAL CONSIDERATIONS.

The coasts of Washington and Oregon, from Cape Flattery to the California boundary line, have a total length, due north and south, of about 383 nautical miles, reaching, therefore, through nearly 6½ degrees of latitude. The examination of this region by the steamer *Albatross* was begun in September, 1888, and was continued at intervals until in October, 1889, when it was practically completed. Since that time, however, some additional observations have been made.

As in the Alaskan region, it has been necessary to spend most time in determining the contour and general characteristics of the bottom, as very few soundings had previously been made beyond a depth of 50 fathoms, and only comparatively limited areas in more shallow water had been surveyed. The regular hydrographic work of the *Albatross* consisted in running parallel lines of soundings seaward from the coast, at intervals of 5 to 10 miles, and generally into depths of 200 or more fathoms, thus serving to develop the entire width of the continental platform to its abrupt outer edge. As the bottom fishing-grounds are mostly confined within a depth of 100 fathoms and rarely extend beyond a depth of 200 fathoms, the survey made here by the *Albatross* has been sufficiently comprehensive to meet all the requirements of the fishery interests in that respect, although in some places more detailed examinations would be desirable. Wherever the nature of the bottom or previous information indicated the occurrence of fishing-grounds, the sounding stations were run more closely together, and the amount of time spent in determining their contours and conditions was proportioned to their importance.

The width of the continental platform varies considerably at different places along the coast. At Cape Flattery the 100-fathom line is 40 miles from shore, while at Cape Johnson, 26 miles further south, it is distant only 18 miles. Off Grays Harbor the distance is 30 miles; off Willapa Bay, 20 miles; off Cape Disappointment, at the mouth of the Columbia River, 15 miles; at Tillamook Rock, Oregon, 27 miles, and at Cape Lookout 11 miles. From this point the platform gradually broadens out, attaining a width of 35 miles off the Siuslaw River, in the region of Heceta Bank, immediately south of which it is abruptly constricted to about 14 miles, becoming reduced to 7 miles at Orford Reef and 12 miles at the California State line.

The superficial area of this platform within the 100-fathom line has been estimated at about 3,700 square miles for the coast of Washington and about 4,750 square miles for the coast of Oregon.

The soundings off Cape Flattery were irregular and suggest the existence of submarine ridges lying parallel with the coast. A very elongate crescent-shaped depression, having depths of 100 to 200 fathoms, extends southward from the mouth of the Strait of Fuca a distance of some 20 or more miles, being distant from the coast from 8 to 12 miles. Thence to Yaquina Head, Oregon, the slope is regular, except in the region of the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms were found. Below Yaquina Head the platform attains its greatest width south of Cape Flattery, the somewhat triangular area which occurs there being occupied at its southwestern extremity by Heceta Bank. Further south the soundings are regular, but the depths increase more rapidly from the shore outward. The bottom consists generally of fine sand in the shallower water, changing

to mud farther offshore, although sand was also found at times in considerable depths. On the fishing-banks its character is variable, as described elsewhere.

Dredging and fishing trials were made at frequent intervals down the coast as far as Orford Reef, Oregon, leaving a distance of about 48 miles between that place and the State line, over which no fishery investigations have yet been made; but the continental platform is there very narrow.

There are very few defined fishing-grounds on the coasts of Washington and Oregon, and those which occur are of small extent. The largest and most important one lies about 11 miles northwesterly from Cape Flattery, and has a total area of about 1,100 square miles. Another, covering only about 110 square miles, is situated off the coast between Grays Harbor and Willapa Bay. A still smaller bank or rocky patch is located about 19 miles southwesterly from Yaquina Head; its area has been estimated at 40 square miles. Heceta Bank, lying off the Siuslaw River, is next in importance to Flattery Bank, having an extent of about 600 square miles.

The small extent of the banks, however, does not indicate a scarcity of fishery resources, as fishes of excellent food quality were found to be pretty generally distributed over the surface of the platform throughout a large part of the region, as described further on. In the immediate vicinity of exposed rocks lying near the coast, which are inhabited by sea lions, fishes were noticed to be rare if not entirely absent in most cases, Orford Reef, however, presenting a notable exception in this respect.

The halibut and the true cod (*Gadus morrhua*) are the species which have been most eagerly sought for by the fishermen along these coasts, but no traces of the latter were discovered by the *Albatross*. The halibut, however, ranges as far south as Monterey, Cal., although it has nowhere been found sufficiently abundant to afford the basis for a special fishery except on Flattery Bank. Scattering specimens were taken by the *Albatross* off Flattery Rocks, off Tillamook Rock, and on Heceta Bank, but the resources of this bank have not yet been fully tested. The species has also been recorded from off Cape Mendocino. The fact that the Indians south of Cape Flattery do not include the halibut among their supplies of food may be regarded as additional evidence that this fish will not be found in any numbers, near the shore at least, within this region.

Several species of rockfish (*Sebastodes*) were abundant upon the banks as well as upon the sandy bottom of the platform. Flounders were taken everywhere, but were most plentiful between depths of 50 and 100 fathoms. A number of species were discovered, some of which are of excellent food quality, and they will offer strong inducements for the introduction of beam-trawl fishing whenever a market has been established for them. Cultus-cod (*Ophiodon elongatus*) were obtained on all the banks and on Orford Reef. Black-cod (*Anoplopoma fimbria*) of good size inhabit the deeper waters, while smaller individuals, together with the ling or Pacific whiting (*Merlucius productus*), occur in moderate depths. Large red edibles hrimps were also frequently captured in the beam trawl; they are distributed through a considerable depth of water.

The principal obstacle at present to the development of extensive sea fisheries on the outer coast of Washington and the coast of Oregon is the lack of markets for disposing of the catch. The scarcity of good harbors is also a very serious inconvenience, and as those which do exist are encumbered with bars, they can be entered in bad weather only with much difficulty. Although gales are of rare occurrence during

the summer, still the coast winds blow constantly from the northward, maintaining a boisterous sea and strong currents. During the winter southeasterly storms are frequent.

List of the more abundant food-fishes taken by the Albatross on the coasts of Washington and Oregon with the beam trawl and hand lines.

[Prepared by Charles H. Townsend.]

Hippoglossus hippoglossus, Halibut.
Atheresthes stomias, Halibut-flounder.
Microstomus pacificus, Deep-sea sole.
Glyptocephalus zachirus, Long-finned sole.
Citharichthys sordidus, Flounder.
Hippoglossoides jordani, Flounder.
Hippoglossoides exilis, Flounder.
Psettichthys melanostictus, Flounder.
Parophrys vetulus, Flounder.
Isopsetta isolepis, Flounder.
Lepidopsetta bilineata, Flounder.
Sebastodes ruber, Red rockfish.
Sebastodes pinniger, Orange rockfish.
Sebastodes flavidus, Yellow-tail rockfish.
Sebastodes rosaceus, Rockfish.
Sebastodes elongatus, Rockfish.
Sebastodes melanops, Rockfish.
Sebastodes paucispinis, Rockfish.
Sebastodes nebulosus, Rockfish, and other smaller species of the same genus.
Anoplopoma fimbria, Black-cod.
Ophiodon elongatus, Cultus-cod.
Merlucius productus, Whiting.
Microgadus proximus, Tomcod.

Large rays and skates, of several edible species, were common. Anchovies and smelts were taken in the beam trawl when used near shore, while in the deeper water beyond the margin of the platform the redfish (*Sebastolobus*) was dredged in abundance. The flesh of the last-named species is rather soft, but edible.

WASHINGTON.

The Straits of Juan de Fuca and Puget Sound.—Only incidental observations have been made in these waters, either while passing through or while in port. Brief accounts of the fisheries in the vicinity of Seattle, Port Townsend, and Victoria will be found in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

The beam trawl has been used at only four stations, two (Nos. 2864, 2865) in the extreme eastern part of the straits, and two (Nos. 3067 and 3068) off Dwamish Head, near the city of Seattle. The former trials were made on September 6, 1888, in depths of 40 and 48 fathoms, but no fishes of economic value were secured. The latter were made on June 8, 1889, in depths of 82 and 135 fathoms, the bottom consisting of green mud. Among the specimens obtained were three species of flounders, hake, skates, several ratfishes (*Chimæra*), shrimps, starfishes, and sea-anemones, but not many of any kind.

In the evening of September 24, 1888, the halibut trawl was set off Kaihsla Point, outside of Neah Bay, the inner end being in 20, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on being hauled 24 dogfish and 2 skates comprised the entire catch. Halibut and black-cod are sometimes taken in close proximity to Neah Bay earlier in the season. The latter species is never abundant there, but during some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food. On October 19, following, a cod trawl was set for half an hour in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe, or black-cod, which had been reported to occur there, but only dogfish were captured, about 40 specimens in all.

reported position of Pamplona Rocks in lat. 59° 03′ N., long. 142° 40′ W., was next visited, but only deep water was found within a radius of 20 miles of this locality.

Character of the bottom on the banks.—Sand was the predominant material composing the bottom on these several banks, a gray sand being the most common. This was combined in many places with pebbles, gravel, or broken shells, which were also recorded separately in some localities. Mud rarely occurred upon the banks or anywhere inside of the 100-fathom line. Rocks were not found upon Davidson Bank, but on Sannak Bank they compose a large part of the bottom, even in the deeper soundings. Rocky patches are numerous on Shumagin and Albatross banks, but were observed only at the extreme western end of Portlock Bank near Kadiak Island. In the region between Sannak Bank and the Shumagin Islands the bottom consists of sand, mud, pebbles, gravel, and rocks, but the last-mentioned material occurs only in the neighborhood of the islands and Sannak Bank. In the corresponding area between the Shumagin Islands and Kadiak Island fine sand was most abundant in depths less than 100 fathoms, with the admixture in places of pebbles, gravel, and broken shells, and occasional patches of mud and coarse sand. Green and blue mud usually composed the bottom in depths over 100 fathoms, but sand and rocks were also recorded.

Off Unalaska sand was traced down to a depth of 228 fathoms, with mud at 261 fathoms. Black sand was found in 342 fathoms just off Davidson Bank, while mud occurred in 435 fathoms off Sannak Bank, with rocky patches at depths of 265 and 464 fathoms. Sand and rocks composed the bottom off Shumagin Bank in 105 to 119 fathoms. Off Albatross and Portlock banks gray sand was discovered in 298 fathoms and black sand in 594 fathoms. Muddy bottom occurs, however, in places close to the 100-fathom line, but in the pocket which indents the southwestern end of the latter bank, with depths of 102 to 166 fathoms, the bottom consists entirely of sand. A rocky spot was found off Albatross Bank in a depth of 485 fathoms.

Dredging trials.—The beam trawl and naturalists' dredge were frequently used upon the banks, resulting in the collection of a large amount of natural-history material. As was to be expected, the assemblage of forms strongly recalls the fauna of the great fishing-banks of eastern North America, and many of the species from these two northern regions are closely related to one another, some also probably being identical. The most conspicuous features in the hauls were the fishes, crustaceans, mollusks, and echinoderms. Edible fishes, crabs, and shrimps were frequently taken, the last mentioned often in great numbers. The dredging operations were entirely subordinated to those of sounding, as it was considered most important to determine first the outlines and contours of the banks, but the results were ample to prove the exceeding richness of the grounds with respect to the lower forms of animal life, upon which their value for fishing is mainly dependent.

Trials for fish.—The trials for fish on these banks and other offshore grounds were made entirely with hand lines. Cod and halibut were the principal species taken, and are the only ones to which we need refer in this connection. Six to nine lines were generally used at each trial, which occupied from fifteen minutes to something over an hour each, according to circumstances. Salt clams and salmon were chiefly employed as bait, and pollock, sculpins, and cod occasionally. The depth at which the fishing was done ranged from 27 to 84 fathoms, and every variety of bottom observed upon the banks was tried.

The trials made by the *Albatross*, as before explained, do not furnish conclusive results with respect to the average size of the fish inhabiting the banks. It is said used by the *Albatross* on leaving Bering Sea, in August of the same year, the trip through being referred to by Capt. Tanner as follows:

> The atmosphere was usually clear, and as we had never used Akutan Pass we availed ourselves of the favorable opportunity of passing through and examining it. There is a clear channel two miles or more in width between Cape Morgan and four small islets lying off Unalga Island, free from dangers except near the shores, with 26 fathoms, rocky bottom, in the narrowest part of the pass.

Unalaska Harbor and adjacent waters.—During the summer of 1888 collecting was extensively carried on in this harbor and in the waters adjacent to it. Seining proved everywhere successful within the limits of the harbor, but the few hauls made at or near its mouth were unproductive, owing probably to the fact that the water there deepens rapidly from the shore outwards. The natives, however, take cod in these exposed positions. The *Oncorhynchus gorbuscha* (humpback salmon), *O. keta* (dog salmon), and *O. nerka* were seined abundantly both in the main harbor and in Captain Harbor at its head. The red-spotted trout (*Salvelinus malma*) was also plentiful in the harbor and in the fresh-water lake. Other common species obtained were the *Pleuronectes stellatus* (starry flounder), *Lepidopsetta bilineata*, *Hemilepidotus jordani*, and *Clupea mirabilis* (herring). The advantages offered by Unalaska for the establishment of fishing stations and the preparation of dried salmon or *ukali* by the natives have been discussed in the Fish Commission reports last referred to above.

The investigations were continued in Unalaska Harbor at intervals during the summer of 1890, and late in the season they were carried along the Bering Sea side of the island from Priest Rock, in the east, to Umnak Island, in the west. Regarding the vicinity of Unalaska Harbor, Mr. Alexander states that the fishing-grounds extend only a short distance from the shore, the width of bottom over which cod may be expected to occur ranging from 3 to 6 miles. The fishing-spots consist of rocky and muddy patches of variable extent, on which sand, gravel, and shells also occur in small quantities. The rocks are generally sharp and would prove destructive to fishing gear. Cod are frequently caught from the wharf and beach in Unalaska Harbor, and there are certain places in Captain Harbor where this species is sufficiently abundant to supply the local demands during the entire year. The fish taken in such localities, however, are inferior in quality to those captured farther off shore, but as salmon form the principal diet of the natives a large stock of cod is never secured at one time. The latter species is almost invariably eaten fresh, but small quantities may be dried in the same manner as the salmon.

According to Capt. Tanner:

> Rumor placed valuable cod banks in the outer bay, but no one seemed to know their exact locality or extent. Such a resource at the doors of a populous settlement would be of inestimable value. Availing ourselves of the opportunity offered by a clear day, we ran several lines of soundings across the bay, making frequent hauls of the trawl and trials with the fishing lines, extending the examination to the 100-fathom line outside of Cape Kalekhta, or Priest Point, and Cape Cheerful, without finding indications of even ordinarily good fishing-ground. In fact, nearly every sounding inside of the capes gave muddy bottom. Spots were discovered, however, near the shore line where cod were plentiful.

At a subsequent time "the search for cod banks in Unalaska Bay was resumed. The region from Ulakta Head to Elder Point was carefully examined, and the examination was extended to Broad and Nateekin Bays, without developing anything that could be called a fishing-bank. Near the shores, however, particularly on the west side of the bay, cod were plentiful and halibut were fairly abundant."

Mr. Alexander reports that the trials made in close proximity to Cape Cheerful indicated the presence of cod in considerable numbers, those captured having an average weight of about 11 pounds. In the vicinity of Priest Point the fishing was less successful, but a diligent search might disclose good bottom here and there, which had been overlooked in the hurried investigations of the *Albatross.* Although halibut have never been found here in abundance, they have not at any time been specially sought for, and it is therefore possible that they may be plentiful in some places.

The bays, harbors, and streams in all parts of the island are well filled with salmon during the proper season, but the run is not sufficiently large to induce the establishment of canneries, as on Kadiak Island and in some other parts of the territory.

Cape Cheerful to Makushin Bay.—The 100-fathom curve lies about 4 miles from shore at Cape Cheerful, but it draws in abruptly to about a mile or less until up with Cape Makushin, where the platform again widens out. From the latter cape a line of soundings was run to Makushin Bay, a large and secure harbor, containing a village of the same name, which consists, however, of only a small frame church, a store belonging to the Alaska Commercial Company, and a dozen barabaras, or native earth huts. As a rule, very poor success attended the trials for fish along this section of the coast, but this may have been due in part to the unfavorable weather which prevailed. In some places cod were fairly abundant, the largest catches being made near shore, although the fish were smaller in such positions than in deeper water. Excellent results were obtained at the entrance to a small indentation or bay, 11 miles east of Cape Makushin, both cod and halibut being secured, three specimens of the latter weighing 6½, 8, and 15 pounds, respectively.

By means of the drag seine, large numbers of humpback salmon, trout, young cod, and flounders were captured in Makushin Bay. The beaches are smooth and well adapted to this method of fishing. Two small streams enter the bay near the settlement. The larger of these brings down considerable quantities of sediment, but this, apparently, does not prevent the salmon from ascending it to the same extent that they do the clear stream.

Makushin Bay to Umnak Island.—At Cape Makushin the coast falls away abruptly toward the south, the entire western part of Unalaska being very narrow, and, together with the adjacent shores of Umnak Island and the coast between Makushin cape and bay, encircling a bay some 32 miles in greatest width. Within these limits the 100-fathom line lies from 12 to 23 miles offshore, furnishing an area of considerable extent, over which the bottom seemed favorable for cod and halibut, the fauna generally resembling that on Baird and Slime banks. Very few fish were obtained, however, until the ship had reached the neighborhood of Chernoffsky, although a more thorough search might show them to be equally abundant to the eastward. The beam trawl was used successfully in the vicinity of Makushin Bay and Cape Hague, but only 5 cod were secured in as many trials with hand lines. Halibut are also reported from these localities, but nothing was learned respecting their abundance.

Excellent cod-fishing was obtained at nearly every station made directly off Chernoffsky Bay, but less success was met with toward and to the west of Umnak Pass, although practically the same character of bottom was observed throughout the entire area. These differences in the abundance of fish were probably only temporary, due to the state of the tide or to other conditions changing from time to time. In one trial off Chernoffsky, in 42 fathoms, 53 cod and 5 halibut were taken on the hand lines

SOUTHEASTERN ALASKA.

Practically nothing has yet been done toward investigating the fishery resources of southeastern Alaska, all of the time suitable and available for work in northern latitudes since the *Albatross* arrived in the North Pacific Ocean having been spent off the southern coast of the Alaska Peninsula, in Bering Sea, and in the sealing investigations of 1891 and 1892. During July, 1889, however, a trip was made through the inland passages of the southeastern part of the territory as far as Juneau, with several members of the Senate Committee on Indian Affairs, who were desirous of inspecting the principal Indian settlements of that region. The steamer left Tacoma on July 8, and returned on the 28th of the same month. Stops were made at Fort Tongass, Port Chester, Karta Bay, Fort Wrangell, Sitka, Pavloff Harbor, Hoonyah Bay, Portage Bay, Chilkat, and Juneau. Several important fishing stations and canneries were visited, and some investigations were also made by means of the beam trawl and other kinds of fishing apparatus.

BRITISH COLUMBIA.

On the voyages to and from Alaska the *Albatross* has generally made use of the inland passage inside of Vancouver Island; she has also often coaled at Departure Bay, and has made occasional visits to Victoria and to other parts of the same island. Opportunities have therefore been afforded, from time to time, to observe the fishery resources of the British Columbian coast, but comparatively little information has been obtained in regard to them. This subject will be discussed in part in connection with the State of Washington, the following notes referring mainly to the inland passage:

Departure Bay.—The results of collecting work during July 10 and 11, 1888, together with notes upon the fisheries, are recorded in the Bulletin for the same year, pp. 51, 52. According to Mr. Alexander, the white fishermen of Departure Bay are exclusively Italians, whose chief occupation during the winter months is the capture of dogfish for their oil. Herring are also very abundant, but they are taken only in small quantities for the benefit of the local trade. The salmon fishery is likewise very limited, being followed by only a few Indians to supply their own wants and the small market at Nanaimo. Cod sometimes enter the bay, but they are said to be more plentiful in deeper water outside. They are described as small fish, averaging about 5 pounds each in weight, and are not often fished for.

A visit to the same place, beginning May 25, 1889, is thus described by Mr. Alexander:

> During the stay in port I was occupied in obtaining additional information respecting the fisheries of the region. A visit was paid to Mr. Vozza, an Italian fisherman, who conducts a small fishing business on one of the islands in the bay. He said that the past winter had been exceptionally mild and consequently the fishing for dogfish much poorer than usual. These fish would visit the bay in large numbers during cold spells, but every time the weather moderated they immediately sought deeper water. It is not probable that the temperature had a direct effect upon the dogfish, but it influenced the presence of the herring on which they feed. The herring usually resort to Departure Bay during the winter in incredible numbers, and the dogfish follow them about from place to place. Several thousand herring were smoked by Mr. Vozza during the preceding winter, but he found no demand for them in Nanaimo or elsewhere. Three thousand gallons of dogfish oil were put up between December 1 and the last of March by two men. The usual yield for the same time is about 5,000 gallons. Mr. Vozza says that the spring run of salmon strikes the Fraser River in March and remains there until the latter part of June. In July the suk-kegh salmon enter the river and continue in it until sometime in August, after which the spring salmon return and are plentiful for three

or four weeks. A form called "cohoes" by the natives predominates during September, and in October there are several species running.

There are now fifteen canneries on the river, three having been built during the present season. The sizes of mesh in the salmon nets are 6, 7½, and 8 inches. The 6-inch mesh is used for the suk-kegh salmon. About 2,000 men are engaged in the fishery this year.

On May 13, 1890, while on the passage to Alaska, Capt. Tanner notes that "schools of herring were seen in the Gulf of Georgia during the evening, pursued by sharks and porpoises. Among the latter several were observed with peculiar markings, the head, back, and sides being black or very dark; belly, tips of fins, and tip of tail, white."

Alert Bay.—Stops were made at this place both going and coming in 1888. There is an Indian village here and also a salmon cannery, where, up to September, 46,000 cases had been put up. Salmon are sometimes very abundant about the bay and neighboring islands, being chiefly fished for by means of seines and gill nets. A large number of suk-kegh salmon (*O. nerka*) were observed at the cannery on July 11. The Indians of the village are mainly occupied in fishing for the cannery.

Fort Rupert.—The *Albatross* stopped at Fort Rupert, or Beaver Harbor, on July 12, 1888, for the purpose of obtaining a supply of clams for use as bait on the Alaskan fishing-grounds. Clams are unusually plentiful in this locality, and with a force of fifteen sailors 10 bushels were secured during a single low tide. Three species are said to occur here in about equal abundance. The large gaper clam (*Schizothærus*) burrows deeply in the bottom at very low tide level, while the *Saxidomus nuttallii* (quahog) and the smaller *Tapes staminea* are usually only 6 or 8 inches below the surface, and may be found anywhere between high and low water mark. During unfavorable seasons for salmon the cannery at Alert Bay has preserved clams, obtaining its supplies from Fort Rupert.

Dredgings.—On the way south through the inland passage, in September, 1888, dredging stations were made in Queen Charlotte Sound, off the southern entrance to Goletas Channel, depth 238 fathoms (No. 2862); and in the Gulf of Georgia, off Fraser River, depth 67 fathoms (No. 2863).

Black-cod.—Much information was obtained at Victoria respecting the black-cod and the attempts made to establish a regular fishery for this highly prized species. References to this subject will be found in the several reports of Capt. Tanner and Mr. Alexander. In October, 1888, the schooner *Theresa*, of Victoria, completed a successful trip, having secured about 3,000 of these fish, many of which weighed from 20 to 25 pounds apiece. They were taken principally in a depth of 210 fathoms, about 5 miles off the Queen Charlotte Islands, trawl lines being used for their capture. A part of the cargo, however, was purchased from the Indians. According to Mr. Alexander, the great depth at which these fish generally live, 150 to 200 fathoms, has undoubtedly had much to do with hindering the establishment of this industry, as the northwestern coast fishermen had never been obliged to go beyond a depth of 50 fathoms for their cod and halibut, and are totally unused to deep-water fishing.

In June, 1889, Mr. Alexander wrote that he had received information of only one trip subsequent to that mentioned above off the coast of the Queen Charlotte Islands. The fish were caught in the vicinity of Gold Harbor, in a depth of 250 fathoms. He takes exception to the customary manner of dressing the fish, by splitting them down the back and leaving the head and backbone attached, which he thinks causes them to rust very quickly, and considers that if prepared like the true cod, or even mess mackerel, they would be in much greater demand.

WASHINGTON AND OREGON.

GENERAL CONSIDERATIONS.

The coasts of Washington and Oregon, from Cape Flattery to the California boundary line, have a total length, due north and south, of about 383 nautical miles, reaching, therefore, through nearly 6½ degrees of latitude. The examination of this region by the steamer *Albatross* was begun in September, 1888, and was continued at intervals until in October, 1889, when it was practically completed. Since that time, however, some additional observations have been made.

As in the Alaskan region, it has been necessary to spend most time in determining the contour and general characteristics of the bottom, as very few soundings had previously been made beyond a depth of 50 fathoms, and only comparatively limited areas in more shallow water had been surveyed. The regular hydrographic work of the *Albatross* consisted in running parallel lines of soundings seaward from the coast, at intervals of 5 to 10 miles, and generally into depths of 200 or more fathoms, thus serving to develop the entire width of the continental platform to its abrupt outer edge. As the bottom fishing-grounds are mostly confined within a depth of 100 fathoms and rarely extend beyond a depth of 200 fathoms, the survey made here by the *Albatross* has been sufficiently comprehensive to meet all the requirements of the fishery interests in that respect, although in some places more detailed examinations would be desirable. Wherever the nature of the bottom or previous information indicated the occurrence of fishing-grounds, the sounding stations were run more closely together, and the amount of time spent in determining their contours and conditions was proportioned to their importance.

The width of the continental platform varies considerably at different places along the coast. At Cape Flattery the 100-fathom line is 40 miles from shore, while at Cape Johnson, 26 miles further south, it is distant only 18 miles. Off Grays Harbor the distance is 30 miles; off Willapa Bay, 20 miles; off Cape Disappointment, at the mouth of the Columbia River, 15 miles; at Tillamook Rock, Oregon, 27 miles, and at Cape Lookout 11 miles. From this point the platform gradually broadens out, attaining a width of 35 miles off the Siuslaw River, in the region of Heceta Bank, immediately south of which it is abruptly constricted to about 14 miles, becoming reduced to 7 miles at Orford Reef and 12 miles at the California State line.

The superficial area of this platform within the 100-fathom line has been estimated at about 3,700 square miles for the coast of Washington and about 4,750 square miles for the coast of Oregon.

The soundings off Cape Flattery were irregular and suggest the existence of submarine ridges lying parallel with the coast. A very elongate crescent-shaped depression, having depths of 100 to 200 fathoms, extends southward from the mouth of the Strait of Fuca a distance of some 20 or more miles, being distant from the coast from 8 to 12 miles. Thence to Yaquina Head, Oregon, the slope is regular, except in the region of the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms were found. Below Yaquina Head the platform attains its greatest width south of Cape Flattery, the somewhat triangular area which occurs there being occupied at its southwestern extremity by Heceta Bank. Further south the soundings are regular, but the depths increase more rapidly from the shore outward. The bottom consists generally of fine sand in the shallower water, changing

to mud farther offshore, although sand was also found at times in considerable depths. On the fishing-banks its character is variable, as described elsewhere.

Dredging and fishing trials were made at frequent intervals down the coast as far as Orford Reef, Oregon, leaving a distance of about 48 miles between that place and the State line, over which no fishery investigations have yet been made; but the continental platform is there very narrow.

There are very few defined fishing-grounds on the coasts of Washington and Oregon, and those which occur are of small extent. The largest and most important one lies about 11 miles northwesterly from Cape Flattery, and has a total area of about 1,100 square miles. Another, covering only about 110 square miles, is situated off the coast between Grays Harbor and Willapa Bay. A still smaller bank or rocky patch is located about 19 miles southwesterly from Yaquina Head; its area has been estimated at 40 square miles. Heceta Bank, lying off the Siuslaw River, is next in importance to Flattery Bank, having an extent of about 600 square miles.

The small extent of the banks, however, does not indicate a scarcity of fishery resources, as fishes of excellent food quality were found to be pretty generally distributed over the surface of the platform throughout a large part of the region, as described further on. In the immediate vicinity of exposed rocks lying near the coast, which are inhabited by sea lions, fishes were noticed to be rare if not entirely absent in most cases, Orford Reef, however, presenting a notable exception in this respect.

The halibut and the true cod (*Gadus morrhua*) are the species which have been most eagerly sought for by the fishermen along these coasts, but no traces of the latter were discovered by the *Albatross*. The halibut, however, ranges as far south as Monterey, Cal., although it has nowhere been found sufficiently abundant to afford the basis for a special fishery except on Flattery Bank. Scattering specimens were taken by the *Albatross* off Flattery Rocks, off Tillamook Rock, and on Heceta Bank, but the resources of this bank have not yet been fully tested. The species has also been recorded from off Cape Mendocino. The fact that the Indians south of Cape Flattery do not include the halibut among their supplies of food may be regarded as additional evidence that this fish will not be found in any numbers, near the shore at least, within this region.

Several species of rockfish (*Sebastodes*) were abundant upon the banks as well as upon the sandy bottom of the platform. Flounders were taken everywhere, but were most plentiful between depths of 50 and 100 fathoms. A number of species were discovered, some of which are of excellent food quality, and they will offer strong inducements for the introduction of beam-trawl fishing whenever a market has been established for them. Cultus-cod (*Ophiodon elongatus*) were obtained on all the banks and on Orford Reef. Black-cod (*Anoplopoma fimbria*) of good size inhabit the deeper waters, while smaller individuals, together with the ling or Pacific whiting (*Merlucius productus*), occur in moderate depths. Large red edibles hrimps were also frequently captured in the beam trawl; they are distributed through a considerable depth of water.

The principal obstacle at present to the development of extensive sea fisheries on the outer coast of Washington and the coast of Oregon is the lack of markets for disposing of the catch. The scarcity of good harbors is also a very serious inconvenience, and as those which do exist are encumbered with bars, they can be entered in bad weather only with much difficulty. Although gales are of rare occurrence during

the summer, still the coast winds blow constantly from the northward, maintaining a boisterous sea and strong currents. During the winter southeasterly storms are frequent.

List of the more abundant food-fishes taken by the Albatross on the coasts of Washington and Oregon with the beam trawl and hand lines.

[Prepared by Charles H. Townsend.]

Hippoglossus hippoglossus, Halibut.
Atheresthes stomias, Halibut-flounder.
Microstomus pacificus, Deep-sea sole.
Glyptocephalus zachirus, Long-finned sole.
Citharichthys sordidus, Flounder.
Hippoglossoides jordani, Flounder.
Hippoglossoides exilis, Flounder.
Psettichthys melanostictus, Flounder.
Parophrys vetulus, Flounder.
Isopsetta isolepis, Flounder.
Lepidopsetta bilineata, Flounder.
Sebastodes ruber, Red rockfish.
Sebastodes pinniger, Orange rockfish.
Sebastodes flavidus, Yellow-tail rockfish.
Sebastodes rosaceus, Rockfish.
Sebastodes elongatus, Rockfish.
Sebastodes melanops, Rockfish.
Sebastodes paucispinis, Rockfish.
Sebastodes nebulosus, Rockfish, and other smaller species of the same genus.
Anoplopoma fimbria, Black-cod.
Ophiodon elongatus, Cultus-cod.
Merlucius productus, Whiting.
Microgadus proximus, Tomcod.

Large rays and skates, of several edible species, were common. Anchovies and smelts were taken in the beam trawl when used near shore, while in the deeper water beyond the margin of the platform the redfish (*Sebastolobus*) was dredged in abundance. The flesh of the last-named species is rather soft, but edible.

WASHINGTON.

The Straits of Juan de Fuca and Puget Sound.—Only incidental observations have been made in these waters, either while passing through or while in port. Brief accounts of the fisheries in the vicinity of Seattle, Port Townsend, and Victoria will be found in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

The beam trawl has been used at only four stations, two (Nos. 2864, 2865) in the extreme eastern part of the straits, and two (Nos. 3067 and 3068) off Dwamish Head, near the city of Seattle. The former trials were made on September 6, 1888, in depths of 40 and 48 fathoms, but no fishes of economic value were secured. The latter were made on June 8, 1889, in depths of 82 and 135 fathoms, the bottom consisting of green mud. Among the specimens obtained were three species of flounders, hake, skates, several ratfishes (*Chimæra*), shrimps, starfishes, and sea-anemones, but not many of any kind.

In the evening of September 24, 1888, the halibut trawl was set off Kalhsla Point, outside of Neah Bay, the inner end being in 20, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on being hauled 24 dogfish and 2 skates comprised the entire catch. Halibut and black-cod are sometimes taken in close proximity to Neah Bay earlier in the season. The latter species is never abundant there, but during some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food. On October 19, following, a cod trawl was set for half an hour in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe, or black-cod, which had been reported to occur there, but only dogfish were captured, about 40 specimens in all.

Mr. Alexander states that—

> There are a few fishermen about Port Townsend and Victoria who fish for halibut and dogfish the greater part of the year. One of these, Mr. Isaac Bakman, with whom I conversed, stated that he did not think that halibut were ever abundant enough in the Straits of Fuca to warrant vessels of large size engaging in the business. In April, 1888, Mr. Bakman secured in different parts of the straits 4,500 pounds of halibut, for which he received from 2 to 3 cents per pound. These spring fish have been very scarce, and not enough have been caught to pay expenses.

During the winter of 1888–89, three men were fishing for cod in Puget Sound with gill nets and trawl lines. No large quantities of these fish were caught, but many flounders and a few halibut were taken on the trawls. The cod are obtained in all depths from 5 fathoms downwards, the deepest water in which gill nets have been set being 150 fathoms, off Quartermaster Harbor, near the head of Puget Sound. In this region both the *Gadus morrhua* and the cultus-cod (*Ophiodon elongatus*) are known under the name of cod.

Flattery Bank.—This bank, which constitutes one of the most important fishing-grounds on the Pacific coast south of British Columbia, is located to the northwestward of Cape Flattery, on the northern side of the deep-water area (from 100 to 200 fathoms) at the entrance to the Strait of Juan de Fuca. It is mostly confined within the 50-fathom curve adjacent to the coast of Vancouver Island, and lies directly off the entrance to Nitinat Lake, but it is also continuous with that part of the continental platform inside of the 100-fathom curve which skirts the outer coast of Washington, although depths of nearly 100 fathoms intervene. Flattery Bank has long been resorted to by the Indians, but, while large quantities of halibut and of other fishes have been taken from it in times past, the first extensive commercial fishery there was attempted about 1888.

As the hydrography of the bank had previously been determined with sufficient accuracy for fishery purposes, the investigations of the *Albatross* were limited for the most part to dredging and fishing trials. The first visit was paid to it in September, 1888, the inquiries being begun on the southeastern part of the bank, nearest Cape Flattery, and being carried thence to the neighborhood of Barclay Sound, Vancouver Island. The second and last examination was made in June, 1889. The entire area of the bank has not yet been surveyed and its extreme limits are, therefore, still unknown. The depths may be said to range from 27 to about 75 fathoms. The bottom varies exceedingly in character, consisting of rocks, sand, mud, and shells, and in some places being very rough and irregular. It supports a very rich fauna, which fits it especially as a feeding-ground for fishes.

Capt. Tanner assigns to this bank a total area of about 1,100 square miles. The least depth of water, 27 fathoms, was found at its southeastern extremity, 11 miles W. by N. (magnetic) from Cape Flattery light-house. Halibut occur most abundantly on the same part of the bank, over an exceedingly rough, rocky bottom, having an area of about 35 square miles. From early in the spring until the middle of June this species can be obtained on Flattery Bank in paying quantities, but later in the season dogfish and sharks strike in, driving a majority of the edible fishes away.

The dredging and fishing trials by the *Albatross* were as follows:

Three dredging stations (2873 to 2875, inclusive) were made on September 24, 1888, at distances of 10 to 12 miles northwesterly from Cape Flattery, the depths ranging from 27 to 40 fathoms, and all varieties of bottom being found. The first trial was with the beam trawl in 40 fathoms, but it caught upon the bottom and was badly

that the larger cod are least quickly attracted by the bait, but as time was too valuable to permit of long stops at any single position, the records showing the size of fish taken by the *Albatross* are less gratifying than might otherwise have been expected. A length of 28 inches is taken as the standard size for large fish on the Atlantic coast, and all under this size bring a lower price in the markets. Out of 20 captures of cod recorded by the *Albatross*, the average size of the fish attained this standard in only six instances; it was rarely below 24 inches, and generally above 25 inches. The trials were usually made during the progress of or subsequent to a sounding or dredging haul, the steamer often drifting with the tide and changing the ground before the lines had touched bottom. By anchoring, and especially by remaining some time in each position, much better results would undoubtedly have been obtained. Halibut were secured at nearly every station.

In four trials made off Unalaska Island, aggregating eighty-five minutes, 22 cod were taken, averaging for the several trials from 21 to 28¾ inches in length; in one instance, on Davidson Bank, 25 cod averaged 28 inches, and in another, 21 cod, 24½ inches; 18 cod captured on Sannak Bank averaged 23½ to 25 inches in length. The cod taken off Unga, one of the Shumagin Islands, had an average length of 30 inches; on Shumagin Bank of 26½ inches, and near the Chirikof Island of 23⅛ inches. Several trials were made on Albatross Bank, two of which were unusually successful. One was off Tugidak, the westernmost of the Trinity Islands, in 37 fathoms, where 47 cod were captured in 38 minutes, and the other off Dangerous Cape, Kadiak, in 39 fathoms, where the capture amounted to 69 cod in 50 minutes. At the former locality the fish averaged 28½ inches in length and at the latter 30¾ inches, in both instances being above the eastern standard. Pair after pair of cod were hauled up in quick succession at each of these localities, and they were seizing the bait as actively at the close of the trials as at the beginning. Only one large catch of cod was made on Portlock Bank, in a depth of 36 fathoms, where 30 individuals, averaging 27 inches in length, were taken in the course of 18 minutes.

Bait.—Bait is as readily obtained in this region as in Bering Sea, and the same custom prevails of fitting out with only a small quantity of salted fish or clams, for which fresh material is substituted as soon as the fishing work actively begins.

Miscellaneous observations.—Besides the fishery investigations summarized above, many other important observations were also made bearing more or less directly on the same subject. These have been discussed in full in the reports previously referred to. They relate to the hydrography and meteorology of the region, the availability of harbors, etc. Corrected positions were obtained for some of the rocks and islands of the Sandman Reefs, which had been inaccurately located on the published charts. An unsuccessful search was made for two reported dangers south of the Sannak Islands, namely, Lenard and Anderson rocks, without, however, disproving their existence. Much valuable information was secured regarding the different islands visited and the mainland at Mitrofania Bay. A partial list of the harbors and anchorages situated between Unalaska and Kadiak was compiled, and sailing directions were also prepared for entering some of the more important ports.

While approaching the Alaskan coast in May, 1890, a second attempt was made to locate the position of Anderson Rock, respecting which Capt. Tanner has reported as follows:

> The high land of Sannak Island was sighted on the morning of May 21, and a line of soundings and dredgings, commenced in 483 fathoms, was carried over the position assigned to Anderson Rock,

and thence to the westward of the islands through Unimak Pass into Bering Sea. The weather was squally and misty at times while working in the region of Anderson Rock, but there were frequent intervals when it was quite clear, and from the masthead we commanded a view of the horizon for 10 miles or more in every direction, but without detecting any surface signs of rocks or shoals; neither did the soundings indicate anything of the kind. Our observations do not prove the non-existence of the danger referred to, but simply show that it does not lie in the position indicated. The evidence seems so conclusive as to the existence of rocks somewhere in that vicinity that I am inclined to the belief that they will eventually be found and located properly. Our investigations are gradually narrowing the limits in which they may be searched for.

A few dredging and fishing trials were also made south of the Alaska Peninsula during the summer of 1890, but they add no information of material importance for this brief review.

DEEP-SEA SOUNDINGS AND DREDGINGS IN THE NORTH PACIFIC OCEAN, OFF THE ALASKAN COAST.

On approaching the Alaskan coast in July, 1888, soundings were begun in a depth of 2,550 fathoms, latitude 52° 15′ N., longitude 156° 37′ W. This was the first of a series of ten stations extending N. 88° W., 390 miles, and made to ascertain whether a marked depression in the bottom, observed farther to the eastward by the U. S. S. *Tuscarora* in 1874, was more than local in its character. The soundings of the *Tuscarora* revealed a depression simply, but from them geologists had predicted the existence of a submarine trough, running parallel to the coast of the Alaska Peninsula and the Aleutian Islands, and extending probably along the entire length of the latter islands to the sounding of 4,037 fathoms made by the *Tuscarora* off Attu Island. The *Albatross* soundings, supplementing those of Capt. Belknap, developed this predicted trough a distance of 400 miles. Its direction, where determined, was S. 65° W. and N. 65° E., nearly parallel with the trend of the coast line, the center being 60 miles from the Shumagins and 100 miles from the southwestern extremity of Unalaska. It is about 30 miles in width between the 3,000-fathom lines, with a maximum depth of 3,820 fathoms in latitude 52° 20′ N., longitude 165° W.

In August, 1890, after leaving Bering Sea, another similar line of soundings was run across the same region, but some distance to the eastward of the *Tuscarora* series. The results have been described by Capt. Tanner as follows:

> Departure was taken off the Trinity Islands in latitude 56° 02′ N., longitude 153° 52′ W. Running E. 3° S. true, 11 miles, we found 207 fathoms; then east true, with intervals of 20 miles, the following depths were found across the line of the great submarine trough which extends along the Aleutian Islands, viz: 1,152, 2,197, 2,620, 2,935, and 2,925 fathoms. Increasing the interval to 30 miles, we found 2,776 fathoms, and a farther distance of 62 miles gave us 2,414 fathoms. The maximum depth was found in latitude 56° 02′ N., longitude 151° 12′ W. It will be observed that while the depths are less than those found farther west, they are at least 800 fathoms greater than the normal, showing that the easterly extension of the depression reaches that point. The line of soundings was extended to the Queen Charlotte Islands, where a successful haul of the trawl was made in 1,588 fathoms.

This depression has therefore now been traced a distance of nearly 600 miles.

After completing the investigations off Middleton Island and Pamplona Rocks, in August, 1888, a line of ten sounding and dredging stations was carried southward, nearly parallel with the coast line of Alaska and British Columbia, to the north end of Vancouver Island. At the first six stations the depths ranged from 1,433 to 1,815 fathoms, but they subsequently decreased to 876, 204, 83, and 52 fathoms.

The foregoing deep-sea soundings and dredgings, as well as those of lesser depth, made to determine the contour of the bottom along the margin of the continental platform off the coast of the Alaska Peninsula, are represented on U. S. Coast and Geodetic Survey charts S and T.

SOUTHEASTERN ALASKA.

Practically nothing has yet been done toward investigating the fishery resources of southeastern Alaska, all of the time suitable and available for work in northern latitudes since the *Albatross* arrived in the North Pacific Ocean having been spent off the southern coast of the Alaska Peninsula, in Bering Sea, and in the sealing investigations of 1891 and 1892. During July, 1889, however, a trip was made through the inland passages of the southeastern part of the territory as far as Juneau, with several members of the Senate Committee on Indian Affairs, who were desirous of inspecting the principal Indian settlements of that region. The steamer left Tacoma on July 8, and returned on the 28th of the same month. Stops were made at Fort Tongass, Port Chester, Karta Bay, Fort Wrangell, Sitka, Pavloff Harbor, Hoonyah Bay, Portage Bay, Chilkat, and Juneau. Several important fishing stations and canneries were visited, and some investigations were also made by means of the beam trawl and other kinds of fishing apparatus.

BRITISH COLUMBIA.

On the voyages to and from Alaska the *Albatross* has generally made use of the inland passage inside of Vancouver Island; she has also often coaled at Departure Bay, and has made occasional visits to Victoria and to other parts of the same island. Opportunities have therefore been afforded, from time to time, to observe the fishery resources of the British Columbian coast, but comparatively little information has been obtained in regard to them. This subject will be discussed in part in connection with the State of Washington, the following notes referring mainly to the inland passage:

Departure Bay.—The results of collecting work during July 10 and 11, 1888, together with notes upon the fisheries, are recorded in the Bulletin for the same year, pp. 51, 52. According to Mr. Alexander, the white fishermen of Departure Bay are exclusively Italians, whose chief occupation during the winter months is the capture of dogfish for their oil. Herring are also very abundant, but they are taken only in small quantities for the benefit of the local trade. The salmon fishery is likewise very limited, being followed by only a few Indians to supply their own wants and the small market at Nanaimo. Cod sometimes enter the bay, but they are said to be more plentiful in deeper water outside. They are described as small fish, averaging about 5 pounds each in weight, and are not often fished for.

A visit to the same place, beginning May 25, 1889, is thus described by Mr. Alexander:

> During the stay in port I was occupied in obtaining additional information respecting the fisheries of the region. A visit was paid to Mr. Vozza, an Italian fisherman, who conducts a small fishing business on one of the islands in the bay. He said that the past winter had been exceptionally mild and consequently the fishing for dogfish much poorer than usual. These fish would visit the bay in large numbers during cold spells, but every time the weather moderated they immediately sought deeper water. It is not probable that the temperature had a direct effect upon the dogfish, but it influenced the presence of the herring on which they feed. The herring usually resort to Departure Bay during the winter in incredible numbers, and the dogfish follow them about from place to place. Several thousand herring were smoked by Mr. Vozza during the preceding winter, but he found no demand for them in Nanaimo or elsewhere. Three thousand gallons of dogfish oil were put up between December 1 and the last of March by two men. The usual yield for the same time is about 5,000 gallons. Mr. Vozza says that the spring run of salmon strikes the Fraser River in March and remains there until the latter part of June. In July the suk-kegh salmon enter the river and continue in it until sometime in August, after which the spring salmon return and are plentiful for three

or four weeks. A form called "cohoes" by the natives predominates during September, and in October there are several species running.

There are now fifteen canneries on the river, three having been built during the present season. The sizes of mesh in the salmon nets are 6, 7½, and 8 inches. The 6-inch mesh is used for the suk-kegh salmon. About 2,000 men are engaged in the fishery this year.

On May 13, 1890, while on the passage to Alaska, Capt. Tanner notes that "schools of herring were seen in the Gulf of Georgia during the evening, pursued by sharks and porpoises. Among the latter several were observed with peculiar markings, the head, back, and sides being black or very dark; belly, tips of fins, and tip of tail, white."

Alert Bay.—Stops were made at this place both going and coming in 1888. There is an Indian village here and also a salmon cannery, where, up to September, 46,000 cases had been put up. Salmon are sometimes very abundant about the bay and neighboring islands, being chiefly fished for by means of seines and gill nets. A large number of suk-kegh salmon (*O. nerka*) were observed at the cannery on July 11. The Indians of the village are mainly occupied in fishing for the cannery.

Fort Rupert.—The *Albatross* stopped at Fort Rupert, or Beaver Harbor, on July 12, 1888, for the purpose of obtaining a supply of clams for use as bait on the Alaskan fishing-grounds. Clams are unusually plentiful in this locality, and with a force of fifteen sailors 10 bushels were secured during a single low tide. Three species are said to occur here in about equal abundance. The large gaper clam (*Schizothærus*) burrows deeply in the bottom at very low tide level, while the *Saxidomus nuttallii* (quahog) and the smaller *Tapes staminea* are usually only 6 or 8 inches below the surface, and may be found anywhere between high and low water mark. During unfavorable seasons for salmon the cannery at Alert Bay has preserved clams, obtaining its supplies from Fort Rupert.

Dredgings.—On the way south through the inland passage, in September, 1888, dredging stations were made in Queen Charlotte Sound, off the southern entrance to Goletas Channel, depth 238 fathoms (No. 2862); and in the Gulf of Georgia, off Fraser River, depth 67 fathoms (No. 2863).

Black-cod.—Much information was obtained at Victoria respecting the black-cod and the attempts made to establish a regular fishery for this highly prized species. References to this subject will be found in the several reports of Capt. Tanner and Mr. Alexander. In October, 1888, the schooner *Theresa*, of Victoria, completed a successful trip, having secured about 3,000 of these fish, many of which weighed from 20 to 25 pounds apiece. They were taken principally in a depth of 210 fathoms, about 5 miles off the Queen Charlotte Islands, trawl lines being used for their capture. A part of the cargo, however, was purchased from the Indians. According to Mr. Alexander, the great depth at which these fish generally live, 150 to 200 fathoms, has undoubtedly had much to do with hindering the establishment of this industry, as the northwestern coast fishermen had never been obliged to go beyond a depth of 50 fathoms for their cod and halibut, and are totally unused to deep-water fishing.

In June, 1889, Mr. Alexander wrote that he had received information of only one trip subsequent to that mentioned above off the coast of the Queen Charlotte Islands. The fish were caught in the vicinity of Gold Harbor, in a depth of 250 fathoms. He takes exception to the customary manner of dressing the fish, by splitting them down the back and leaving the head and backbone attached, which he thinks causes them to rust very quickly, and considers that if prepared like the true cod, or even mess mackerel, they would be in much greater demand.

WASHINGTON AND OREGON.

GENERAL CONSIDERATIONS.

The coasts of Washington and Oregon, from Cape Flattery to the California boundary line, have a total length, due north and south, of about 383 nautical miles, reaching, therefore, through nearly 6½ degrees of latitude. The examination of this region by the steamer *Albatross* was begun in September, 1888, and was continued at intervals until in October, 1889, when it was practically completed. Since that time, however, some additional observations have been made.

As in the Alaskan region, it has been necessary to spend most time in determining the contour and general characteristics of the bottom, as very few soundings had previously been made beyond a depth of 50 fathoms, and only comparatively limited areas in more shallow water had been surveyed. The regular hydrographic work of the *Albatross* consisted in running parallel lines of soundings seaward from the coast, at intervals of 5 to 10 miles, and generally into depths of 200 or more fathoms, thus serving to develop the entire width of the continental platform to its abrupt outer edge. As the bottom fishing-grounds are mostly confined within a depth of 100 fathoms and rarely extend beyond a depth of 200 fathoms, the survey made here by the *Albatross* has been sufficiently comprehensive to meet all the requirements of the fishery interests in that respect, although in some places more detailed examinations would be desirable. Wherever the nature of the bottom or previous information indicated the occurrence of fishing-grounds, the sounding stations were run more closely together, and the amount of time spent in determining their contours and conditions was proportioned to their importance.

The width of the continental platform varies considerably at different places along the coast. At Cape Flattery the 100-fathom line is 40 miles from shore, while at Cape Johnson, 26 miles further south, it is distant only 18 miles. Off Grays Harbor the distance is 30 miles; off Willapa Bay, 20 miles; off Cape Disappointment, at the mouth of the Columbia River, 15 miles; at Tillamook Rock, Oregon, 27 miles, and at Cape Lookout 11 miles. From this point the platform gradually broadens out, attaining a width of 35 miles off the Siuslaw River, in the region of Heceta Bank, immediately south of which it is abruptly constricted to about 14 miles, becoming reduced to 7 miles at Orford Reef and 12 miles at the California State line.

The superficial area of this platform within the 100-fathom line has been estimated at about 3,700 square miles for the coast of Washington and about 4,750 square miles for the coast of Oregon.

The soundings off Cape Flattery were irregular and suggest the existence of submarine ridges lying parallel with the coast. A very elongate crescent-shaped depression, having depths of 100 to 200 fathoms, extends southward from the mouth of the Strait of Fuca a distance of some 20 or more miles, being distant from the coast from 8 to 12 miles. Thence to Yaquina Head, Oregon, the slope is regular, except in the region of the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms were found. Below Yaquina Head the platform attains its greatest width south of Cape Flattery, the somewhat triangular area which occurs there being occupied at its southwestern extremity by Heceta Bank. Further south the soundings are regular, but the depths increase more rapidly from the shore outward. The bottom consists generally of fine sand in the shallower water, changing

to mud farther offshore, although sand was also found at times in considerable depths. On the fishing-banks its character is variable, as described elsewhere.

Dredging and fishing trials were made at frequent intervals down the coast as far as Orford Reef, Oregon, leaving a distance of about 48 miles between that place and the State line, over which no fishery investigations have yet been made; but the continental platform is there very narrow.

There are very few defined fishing-grounds on the coasts of Washington and Oregon, and those which occur are of small extent. The largest and most important one lies about 11 miles northwesterly from Cape Flattery, and has a total area of about 1,100 square miles. Another, covering only about 110 square miles, is situated off the coast between Grays Harbor and Willapa Bay. A still smaller bank or rocky patch is located about 19 miles southwesterly from Yaquina Head; its area has been estimated at 40 square miles. Heceta Bank, lying off the Siuslaw River, is next in importance to Flattery Bank, having an extent of about 600 square miles.

The small extent of the banks, however, does not indicate a scarcity of fishery resources, as fishes of excellent food quality were found to be pretty generally distributed over the surface of the platform throughout a large part of the region, as described further on. In the immediate vicinity of exposed rocks lying near the coast, which are inhabited by sea lions, fishes were noticed to be rare if not entirely absent in most cases, Orford Reef, however, presenting a notable exception in this respect.

The halibut and the true cod (*Gadus morrhua*) are the species which have been most eagerly sought for by the fishermen along these coasts, but no traces of the latter were discovered by the *Albatross*. The halibut, however, ranges as far south as Monterey, Cal., although it has nowhere been found sufficiently abundant to afford the basis for a special fishery except on Flattery Bank. Scattering specimens were taken by the *Albatross* off Flattery Rocks, off Tillamook Rock, and on Heceta Bank, but the resources of this bank have not yet been fully tested. The species has also been recorded from off Cape Mendocino. The fact that the Indians south of Cape Flattery do not include the halibut among their supplies of food may be regarded as additional evidence that this fish will not be found in any numbers, near the shore at least, within this region.

Several species of rockfish (*Sebastodes*) were abundant upon the banks as well as upon the sandy bottom of the platform. Flounders were taken everywhere, but were most plentiful between depths of 50 and 100 fathoms. A number of species were discovered, some of which are of excellent food quality, and they will offer strong inducements for the introduction of beam-trawl fishing whenever a market has been established for them. Cultus-cod (*Ophiodon elongatus*) were obtained on all the banks and on Orford Reef. Black-cod (*Anoplopoma fimbria*) of good size inhabit the deeper waters, while smaller individuals, together with the ling or Pacific whiting (*Merlucius productus*), occur in moderate depths. Large red edibles hrimps were also frequently captured in the beam trawl; they are distributed through a considerable depth of water.

The principal obstacle at present to the development of extensive sea fisheries on the outer coast of Washington and the coast of Oregon is the lack of markets for disposing of the catch. The scarcity of good harbors is also a very serious inconvenience, and as those which do exist are encumbered with bars, they can be entered in bad weather only with much difficulty. Although gales are of rare occurrence during

the summer, still the coast winds blow constantly from the northward, maintaining a boisterous sea and strong currents. During the winter southeasterly storms are frequent.

List of the more abundant food-fishes taken by the Albatross on the coasts of Washington and Oregon with the beam trawl and hand lines.

[Prepared by Charles H. Townsend.]

Hippoglossus hippoglossus, Halibut.
Atheresthes stomias, Halibut-flounder.
Microstomus pacificus, Deep-sea sole.
Glyptocephalus zachirus, Long-finned sole.
Citharichthys sordidus, Flounder.
Hippoglossoides jordani, Flounder.
Hippoglossoides exilis, Flounder.
Psettichthys melanostictus, Flounder.
Parophrys vetulus, Flounder.
Isopsetta isolepis, Flounder.
Lepidopsetta bilineata, Flounder.
Sebastodes ruber, Red rockfish.
Sebastodes pinniger, Orange rockfish.
Sebastodes flavidus, Yellow-tail rockfish.
Sebastodes rosaceus, Rockfish.
Sebastodes elongatus, Rockfish.
Sebastodes melanops, Rockfish.
Sebastodes paucispinis, Rockfish.
Sebastodes nebulosus, Rockfish, and other smaller species of the same genus.
Anoplopoma fimbria, Black-cod.
Ophiodon elongatus, Cultus-cod.
Merlucius productus, Whiting.
Microgadus proximus, Tomcod.

Large rays and skates, of several edible species, were common. Anchovies and smelts were taken in the beam trawl when used near shore, while in the deeper water beyond the margin of the platform the redfish (*Sebastolobus*) was dredged in abundance. The flesh of the last-named species is rather soft, but edible.

WASHINGTON.

The Straits of Juan de Fuca and Puget Sound.—Only incidental observations have been made in these waters, either while passing through or while in port. Brief accounts of the fisheries in the vicinity of Seattle, Port Townsend, and Victoria will be found in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

The beam trawl has been used at only four stations, two (Nos. 2864, 2865) in the extreme eastern part of the straits, and two (Nos. 3067 and 3068) off Dwamish Head, near the city of Seattle. The former trials were made on September 6, 1888, in depths of 40 and 48 fathoms, but no fishes of economic value were secured. The latter were made on June 8, 1889, in depths of 82 and 135 fathoms, the bottom consisting of green mud. Among the specimens obtained were three species of flounders, hake, skates, several ratfishes (*Chimæra*), shrimps, starfishes, and sea-anemones, but not many of any kind.

In the evening of September 24, 1888, the halibut trawl was set off Kalhsla Point, outside of Neah Bay, the inner end being in 20, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on being hauled 24 dogfish and 2 skates comprised the entire catch. Halibut and black-cod are sometimes taken in close proximity to Neah Bay earlier in the season. The latter species is never abundant there, but during some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food. On October 19, following, a cod trawl was set for half an hour in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe, or black-cod, which had been reported to occur there, but only dogfish were captured, about 40 specimens in all.

Mr. Alexander states that—

> There are a few fishermen about Port Townsend and Victoria who fish for halibut and dogfish the greater part of the year. One of these, Mr. Isaac Bakman, with whom I conversed, stated that he did not think that halibut were ever abundant enough in the Straits of Fuca to warrant vessels of large size engaging in the business. In April, 1888, Mr. Bakman secured in different parts of the straits 4,500 pounds of halibut, for which he received from 2 to 3 cents per pound. These spring fish have been very scarce, and not enough have been caught to pay expenses.

During the winter of 1888–89, three men were fishing for cod in Puget Sound with gill nets and trawl lines. No large quantities of these fish were caught, but many flounders and a few halibut were taken on the trawls. The cod are obtained in all depths from 5 fathoms downwards, the deepest water in which gill nets have been set being 150 fathoms, off Quartermaster Harbor, near the head of Puget Sound. In this region both the *Gadus morrhua* and the cultus-cod (*Ophiodon elongatus*) are known under the name of cod.

Flattery Bank.—This bank, which constitutes one of the most important fishing-grounds on the Pacific coast south of British Columbia, is located to the northwestward of Cape Flattery, on the northern side of the deep-water area (from 100 to 200 fathoms) at the entrance to the Strait of Juan de Fuca. It is mostly confined within the 50-fathom curve adjacent to the coast of Vancouver Island, and lies directly off the entrance to Nitinat Lake, but it is also continuous with that part of the continental platform inside of the 100-fathom curve which skirts the outer coast of Washington, although depths of nearly 100 fathoms intervene. Flattery Bank has long been resorted to by the Indians, but, while large quantities of halibut and of other fishes have been taken from it in times past, the first extensive commercial fishery there was attempted about 1888.

As the hydrography of the bank had previously been determined with sufficient accuracy for fishery purposes, the investigations of the *Albatross* were limited for the most part to dredging and fishing trials. The first visit was paid to it in September, 1888, the inquiries being begun on the southeastern part of the bank, nearest Cape Flattery, and being carried thence to the neighborhood of Barclay Sound, Vancouver Island. The second and last examination was made in June, 1889. The entire area of the bank has not yet been surveyed and its extreme limits are, therefore, still unknown. The depths may be said to range from 27 to about 75 fathoms. The bottom varies exceedingly in character, consisting of rocks, sand, mud, and shells, and in some places being very rough and irregular. It supports a very rich fauna, which fits it especially as a feeding-ground for fishes.

Capt. Tanner assigns to this bank a total area of about 1,100 square miles. The least depth of water, 27 fathoms, was found at its southeastern extremity, 11 miles W. by N. (magnetic) from Cape Flattery light-house. Halibut occur most abundantly on the same part of the bank, over an exceedingly rough, rocky bottom, having an area of about 35 square miles. From early in the spring until the middle of June this species can be obtained on Flattery Bank in paying quantities, but later in the season dogfish and sharks strike in, driving a majority of the edible fishes away.

The dredging and fishing trials by the *Albatross* were as follows:

Three dredging stations (2873 to 2875, inclusive) were made on September 24, 1888, at distances of 10 to 12 miles northwesterly from Cape Flattery, the depths ranging from 27 to 40 fathoms, and all varieties of bottom being found. The first trial was with the beam trawl in 40 fathoms, but it caught upon the bottom and was badly

wrecked. The tangles were then used successively in depths of 27 and 40 fathoms, with good results. A trawl line, baited with salt salmon and red rockfish, was set for three hours in about the same position on rocky bottom, depth 40 fathoms, the catch consisting of 4 halibut, 2 sharks, 4 red rockfish, and 2 starfishes. The average weight of the halibut was 47¾ pounds; three were females and one was a male; they were all white. It is said that gray halibut are seldom found in these waters.

On September 25 work was continued in nearly the same locality as on the previous day. The beam trawl was cast at station No. 2876, 2 or 3 miles northeasterly from stations 2873 to 2875, and the trawl line, baited with salmon, red rockfish, and fresh halibut, was set at the same time. The depth was 59 fathoms, and the bottom consisted of black sand and mud. The beam trawl dragged but a few yards, when it caught on a rocky patch, parted the bridle stops, and came up tail first. It was, however, a successful haul, and many specimens were found in the net. The tangles were subsequently hauled over the same ground (station 2877) with good results, giving evidence of the richness of the bottom. The towing net, which was frequently used in this region, however, gave very little evidence of surface life. The halibut trawl remained on the bottom three hours, and the catch consisted of 2 halibut, 1 red rockfish, and 9 dogfish, the average weight of the halibut being 55 pounds.

On the afternoon of September 25 the trawl line was set and the dredge lowered in 66 fathoms, gravel and pebbles (station 2878), S. 48° W., 16 miles from Cape Beale light-house, on the southern side of the entrance to Barclay Sound, Vancouver Island. The contents of the dredge, consisting for the most part of small mollusks, did not bear evidence of a rich bottom. The same bait was used upon the trawl line as in the previous trial, and the capture after two hours' time consisted of 2 black-cod, 15 dogfish, 2 common sharks, and 2 ground sharks. Only a small quantity of surface organisms was taken in the tow nets.

Early on the following day two dredge hauls were made at stations 2879 and 2880, 27 miles N. 79° W. from Cape Beale, in 34 fathoms, rocky bottom, with about the same results as at station 2878, the bottom not being rich so far as the contents of the dredge indicated. A trial with the halibut trawl in the same locality, lasting about three hours, afforded 1 halibut weighing 25 pounds, 2 sharks, and 3 dogfish.

At station 2881, in the same neighborhood, but much nearer the coast, Cape Beale bearing S. 26° E., distant 26 miles, the dredge was cast in 24 fathoms, on a rough bottom, with fine gray sand in places. The results were not favorable to good fishing. The trawl line set in the same position took 1 halibut weighing 15 pounds, 5 dogfish, 1 shark, and 1 skate. The trawl, when it came up, was covered with "slime," which was contrary to expectations, as the dredging which preceded it indicated clean bottom.

September 27 and 28 were spent in Barclay Sound, and the following day a skate of halibut trawl was set in 60 fathoms of water, sandy and rocky bottom, 22 miles S. 14° E. from Cape Beale. The trawl was kept down about two hours, with the result of capturing 16 dogfish, 1 beshowe or black-cod, 1 cultus-cod, and 3 small halibut. This spot would probably be a good one for halibut earlier in the season, before the dogfish set in, and is convenient to the Straits of Fuca. It requires examination in the spring or winter to determine its merits.

On June 14, 1889, the trawl line was set on Flattery Bank, in a depth of 31 fathoms, Cape Flattery bearing E. by S. ½ S. and Cape Beale NW. by W. The bottom consisted of gravel, broken shells, and rocks. The tide was running ebb, but not strong, and a dense fog prevailed. The trawl was left down about three hours, at the end of which time the following fish were taken from the hooks: 8 halibut, averaging 35 pounds each; 10 red rockfish, averaging 10 pounds each; 2 orange rockfish; 1 sea trout; 1 cultus-cod, weighing 19 pounds; 1 skate, and 45 dogfish. The bottom was so rough that many of the hooks caught upon it while hauling, and toward the end the ground line parted, but none of the gear was lost. One small halibut and about a dozen dogfish were caught with hand lines from the small boats tending the trawl, and during the same time one halibut weighing 93 pounds and several red rockfish were taken by the same means from the deck of the *Albatross*. A native canoe with four Indians, which came alongside during the day, contained 15 small halibut which had been captured with the primitive wooden hooks.

Barclay Sound, Vancouver Island.—On September 26, 1888, the *Albatross* anchored in Barclay Sound, where she was detained by fog for two days, enabling the naturalists to make some interesting observations upon the natural history of the region. A rich and diversified fauna was discovered, and many specimens were collected. There are not many beaches adapted to seining, but some were found on which a large variety of shore fishes was obtained. Salmon were seen darting about in every direction. They are said to be very plentiful at the head waters of the sound, where they enter the creeks and inlets to spawn. A few large specimens were caught by trolling. A cod trawl, baited with halibut and salmon, was also set one evening in a depth of 17 fathoms, and allowed to remain down over night. The next morning 28 dogfish and 1 red rockfish were found upon the hooks.

Notes on the Halibut Fishery.—The following notes on the halibut fisheries located off the coast of Washington or tributary to its ports are such only as have been furnished through the medium of the *Albatross*, and are here given to illustrate in a practical manner the resources of the grounds. For further information on the same subject reference should be made to the Bulletin for 1888, pp. 62–64, and the Annual Report for 1888, pp. 260–266.

Until within a few years the halibut fisheries of Washington have been almost exclusively the property of the Indians resident upon certain portions of the coast. Beginning in 1888, however, strenuous efforts have been made to establish an extensive commercial fishery, the final outcome of which is still to be decided. The promoters of this enterprise have, unfortunately, encountered many obstacles in the matter of obtaining ice and of shipping their catch to market, which, tending to restrict their operations, has prevented a thorough testing of the grounds; and yet, within certain limits, good results have already been accomplished.

The Indians of Neah Bay visit Flattery Bank daily during the halibut season, whenever the weather permits, and also fish on less important grounds closer at hand; they bring in considerable quantities of halibut, cultus-cod, and red rockfish; herring, smelt, and squid, as well as halibut and red rockfish, are used as bait.

The first vessel fishery appears to have been started in 1888 by two well-equipped schooners, the *Mollie Adams* and the *Oscar and Hattie*, which had recently arrived from Gloucester, Mass. After completing a successful sealing voyage in the spring of that year, the *Mollie Adams* made four trips in quick succession to Flattery Bank, securing, in all, 145,000 pounds of halibut, which were landed at Seattle. The stock amounted to $3,000, the crew receiving shares of $75 each. The expenses were high, however, $15 per ton having been paid for ice on the first trip, although the price was subsequently reduced to $8. During the same season the *Oscar and Hattie* obtained one fare of 50,000 pounds of halibut on Flattery Bank; the fish were landed at Tacoma. But little or nothing was realized from the trip.

In the fall of 1888, several fishermen, well equipped with dories, trawls, etc., established a camp in the vicinity of Neah Bay, and fished continuously throughout the following winter on Flattery Bank and directly off Cape Flattery. Mr. Moor, one of the members of this party, who came to the Pacific coast in the schooner *Mollie Adams*, has furnished a synopsis of the winter fishing. They first set trawls on November 23, 1888, and from that date up to January 7, 1889, succeeded in landing 2,076 pounds of halibut and 244 pounds of cultus-cod. The average weight of the halibut was 37 pounds, and of the cultus-cod 24 pounds. After January 7 little was done, owing to the scarcity of fish and bait and the prevalence of stormy weather. Mr. Moor does not think it advisable to send vessels to Flattery Bank earlier than the 1st of March nor later than the 1st of September. He thinks that halibut are abundant from March to June, but they do not occur in the incredible numbers which have been reported from time to time.

In November, 1888, Capt. Silas Calder, then of the *Mollie Adams*, made a series of trials for halibut on Flattery Bank, without, however, securing a single specimen. He is of the opinion that vessels could obtain good fares during a few months of each year, and might find the business profitable if there were a market for the catch.

The yacht *C. H. White*, of San Francisco, chartered in the fall of 1888 by Messrs. Louch and Johnson, of Seattle, obtained 100,000 pounds of halibut during three trips to the same bank. About 60,000 pounds were shipped fresh to New York, the remainder being smoked.

Several interesting trips at different seasons of the year have also been made farther north than Flattery Bank. While the results accomplished in that direction are not sufficient to serve as a basis for positive conclusions regarding the abundance of halibut in the places visited, which undoubtedly varies at different times of the year, they are at least suggestive and worthy of notice in this connection.

On July 24, 1888, the *Mollie Adams* left Seattle with the object of testing the bottom along the coast of British Columbia. Trials were made in several localities, but few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in greater abundance and of larger size than on Flattery Bank. A few of those obtained were estimated to weigh over 300 pounds apiece. Fishing was carried on in depths of only 30 to 45 fathoms, the fish taking the bait so rapidly that the trawls were left down only during the day time. The work continued until September 8, with slight intermissions on account of stormy weather. About half the halibut secured were large enough for fletching, the remainder being used as bait or thrown away. The total fare carried to Seattle amounted to 150,000 pounds. After deducting all expenses the crew received $175 each, or at the rate of $9 a day for 19 days' fishing.

On January 3, 1889, the schooner *Oscar and Hattie* sailed from Port Townsend on a similar errand, but proceeded directly to Sitka, Alaska, and began fishing on the inshore grounds adjacent to Baranof Island, where halibut had been reported as very abundant. Work was continued, as the weather permitted, until March 1, but not enough fish were taken to keep the hooks baited. The vessel was subsequently shifted to deeper water off shore, but without securing any better success. Early in March she proceeded down the coast, fishing until June 1 in the neighborhood of the Queen Charlotte Islands, Cape Scott, and Hecate Channel. Halibut were more com-

and thence to the westward of the islands through Unimak Pass into Bering Sea. The weather was squally and misty at times while working in the region of Anderson Rock, but there were frequent intervals when it was quite clear, and from the masthead we commanded a view of the horizon for 10 miles or more in every direction, but without detecting any surface signs of rocks or shoals; neither did the soundings indicate anything of the kind. Our observations do not prove the non-existence of the danger referred to, but simply show that it does not lie in the position indicated. The evidence seems so conclusive as to the existence of rocks somewhere in that vicinity that I am inclined to the belief that they will eventually be found and located properly. Our investigations are gradually narrowing the limits in which they may be searched for.

A few dredging and fishing trials were also made south of the Alaska Peninsula during the summer of 1890, but they add no information of material importance for this brief review.

DEEP-SEA SOUNDINGS AND DREDGINGS IN THE NORTH PACIFIC OCEAN, OFF THE ALASKAN COAST.

On approaching the Alaskan coast in July, 1888, soundings were begun in a depth of 2,550 fathoms, latitude 52° 15′ N., longitude 156° 37′ W. This was the first of a series of ten stations extending N. 88° W., 390 miles, and made to ascertain whether a marked depression in the bottom, observed farther to the eastward by the U. S. S. *Tuscarora* in 1874, was more than local in its character. The soundings of the *Tuscarora* revealed a depression simply, but from them geologists had predicted the existence of a submarine trough, running parallel to the coast of the Alaska Peninsula and the Aleutian Islands, and extending probably along the entire length of the latter islands to the sounding of 4,037 fathoms made by the *Tuscarora* off Attu Island. The *Albatross* soundings, supplementing those of Capt. Belknap, developed this predicted trough a distance of 400 miles. Its direction, where determined, was S. 65° W. and N. 65° E., nearly parallel with the trend of the coast line, the center being 60 miles from the Shumagins and 100 miles from the southwestern extremity of Unalaska. It is about 30 miles in width between the 3,000-fathom lines, with a maximum depth of 3,820 fathoms in latitude 52° 20′ N., longitude 165° W.

In August, 1890, after leaving Bering Sea, another similar line of soundings was run across the same region, but some distance to the eastward of the *Tuscarora* series. The results have been described by Capt. Tanner as follows:

> Departure was taken off the Trinity Islands in latitude 56° 02′ N., longitude 153° 52′ W. Running E. 3° S. true, 11 miles, we found 207 fathoms; then east true, with intervals of 20 miles, the following depths were found across the line of the great submarine trough which extends along the Aleutian Islands, viz: 1,152, 2,197, 2,620, 2,935, and 2,925 fathoms. Increasing the interval to 30 miles, we found 2,776 fathoms, and a farther distance of 62 miles gave us 2,414 fathoms. The maximum depth was found in latitude 56° 02′ N., longitude 151° 12′ W. It will be observed that while the depths are less than those found farther west, they are at least 800 fathoms greater than the normal, showing that the easterly extension of the depression reaches that point. The line of soundings was extended to the Queen Charlotte Islands, where a successful haul of the trawl was made in 1,588 fathoms.

This depression has therefore now been traced a distance of nearly 600 miles.

After completing the investigations off Middleton Island and Pamplona Rocks, in August, 1888, a line of ten sounding and dredging stations was carried southward, nearly parallel with the coast line of Alaska and British Columbia, to the north end of Vancouver Island. At the first six stations the depths ranged from 1,433 to 1,815 fathoms, but they subsequently decreased to 876, 204, 83, and 52 fathoms.

The foregoing deep-sea soundings and dredgings, as well as those of lesser depth, made to determine the contour of the bottom along the margin of the continental platform off the coast of the Alaska Peninsula, are represented on U. S. Coast and Geodetic Survey charts S and T.

SOUTHEASTERN ALASKA.

Practically nothing has yet been done toward investigating the fishery resources of southeastern Alaska, all of the time suitable and available for work in northern latitudes since the *Albatross* arrived in the North Pacific Ocean having been spent off the southern coast of the Alaska Peninsula, in Bering Sea, and in the sealing investigations of 1891 and 1892. During July, 1889, however, a trip was made through the inland passages of the southeastern part of the territory as far as Juneau, with several members of the Senate Committee on Indian Affairs, who were desirous of inspecting the principal Indian settlements of that region. The steamer left Tacoma on July 8, and returned on the 28th of the same month. Stops were made at Fort Tongass, Port Chester, Karta Bay, Fort Wrangell, Sitka, Pavloff Harbor, Hoonyah Bay, Portage Bay, Chilkat, and Juneau. Several important fishing stations and canneries were visited, and some investigations were also made by means of the beam trawl and other kinds of fishing apparatus.

BRITISH COLUMBIA.

On the voyages to and from Alaska the *Albatross* has generally made use of the inland passage inside of Vancouver Island; she has also often coaled at Departure Bay, and has made occasional visits to Victoria and to other parts of the same island. Opportunities have therefore been afforded, from time to time, to observe the fishery resources of the British Columbian coast, but comparatively little information has been obtained in regard to them. This subject will be discussed in part in connection with the State of Washington, the following notes referring mainly to the inland passage:

Departure Bay.—The results of collecting work during July 10 and 11, 1888, together with notes upon the fisheries, are recorded in the Bulletin for the same year, pp. 51, 52. According to Mr. Alexander, the white fishermen of Departure Bay are exclusively Italians, whose chief occupation during the winter months is the capture of dogfish for their oil. Herring are also very abundant, but they are taken only in small quantities for the benefit of the local trade. The salmon fishery is likewise very limited, being followed by only a few Indians to supply their own wants and the small market at Nanaimo. Cod sometimes enter the bay, but they are said to be more plentiful in deeper water outside. They are described as small fish, averaging about 5 pounds each in weight, and are not often fished for.

A visit to the same place, beginning May 25, 1889, is thus described by Mr. Alexander:

> During the stay in port I was occupied in obtaining additional information respecting the fisheries of the region. A visit was paid to Mr. Vozza, an Italian fisherman, who conducts a small fishing business on one of the islands in the bay. He said that the past winter had been exceptionally mild and consequently the fishing for dogfish much poorer than usual. These fish would visit the bay in large numbers during cold spells, but every time the weather moderated they immediately sought deeper water. It is not probable that the temperature had a direct effect upon the dogfish, but it influenced the presence of the herring on which they feed. The herring usually resort to Departure Bay during the winter in incredible numbers, and the dogfish follow them about from place to place. Several thousand herring were smoked by Mr. Vozza during the preceding winter, but he found no demand for them in Nanaimo or elsewhere. Three thousand gallons of dogfish oil were put up between December 1 and the last of March by two men. The usual yield for the same time is about 5,000 gallons. Mr. Vozza says that the spring run of salmon strikes the Fraser River in March and remains there until the latter part of June. In July the suk-kegh salmon enter the river and continue in it until sometime in August, after which the spring salmon return and are plentiful for three

or four weeks. A form called "cohoes" by the natives predominates during September, and in October there are several species running.

There are now fifteen canneries on the river, three having been built during the present season. The sizes of mesh in the salmon nets are 6, 7¾, and 8 inches. The 6-inch mesh is used for the suk-kegh salmon. About 2,000 men are engaged in the fishery this year.

On May 13, 1890, while on the passage to Alaska, Capt. Tanner notes that "schools of herring were seen in the Gulf of Georgia during the evening, pursued by sharks and porpoises. Among the latter several were observed with peculiar markings, the head, back, and sides being black or very dark; belly, tips of fins, and tip of tail, white."

Alert Bay.—Stops were made at this place both going and coming in 1888. There is an Indian village here and also a salmon cannery, where, up to September, 46,000 cases had been put up. Salmon are sometimes very abundant about the bay and neighboring islands, being chiefly fished for by means of seines and gill nets. A large number of suk-kegh salmon (*O. nerka*) were observed at the cannery on July 11. The Indians of the village are mainly occupied in fishing for the cannery.

Fort Rupert.—The *Albatross* stopped at Fort Rupert, or Beaver Harbor, on July 12, 1888, for the purpose of obtaining a supply of clams for use as bait on the Alaskan fishing-grounds. Clams are unusually plentiful in this locality, and with a force of fifteen sailors 10 bushels were secured during a single low tide. Three species are said to occur here in about equal abundance. The large gaper clam (*Schizothærus*) burrows deeply in the bottom at very low tide level, while the *Saxidomus nuttallii* (quahog) and the smaller *Tapes staminea* are usually only 6 or 8 inches below the surface, and may be found anywhere between high and low water mark. During unfavorable seasons for salmon the cannery at Alert Bay has preserved clams, obtaining its supplies from Fort Rupert.

Dredgings.—On the way south through the inland passage, in September, 1888, dredging stations were made in Queen Charlotte Sound, off the southern entrance to Goletas Channel, depth 238 fathoms (No. 2862); and in the Gulf of Georgia, off Fraser River, depth 67 fathoms (No. 2863).

Black-cod.—Much information was obtained at Victoria respecting the black-cod and the attempts made to establish a regular fishery for this highly prized species. References to this subject will be found in the several reports of Capt. Tanner and Mr. Alexander. In October, 1888, the schooner *Theresa*, of Victoria, completed a successful trip, having secured about 3,000 of these fish, many of which weighed from 20 to 25 pounds apiece. They were taken principally in a depth of 210 fathoms, about 5 miles off the Queen Charlotte Islands, trawl lines being used for their capture. A part of the cargo, however, was purchased from the Indians. According to Mr. Alexander, the great depth at which these fish generally live, 150 to 200 fathoms, has undoubtedly had much to do with hindering the establishment of this industry, as the northwestern coast fishermen had never been obliged to go beyond a depth of 50 fathoms for their cod and halibut, and are totally unused to deep-water fishing.

In June, 1889, Mr. Alexander wrote that he had received information of only one trip subsequent to that mentioned above off the coast of the Queen Charlotte Islands. The fish were caught in the vicinity of Gold Harbor, in a depth of 250 fathoms. He takes exception to the customary manner of dressing the fish, by splitting them down the back and leaving the head and backbone attached, which he thinks causes them to rust very quickly, and considers that if prepared like the true cod, or even mess mackerel, they would be in much greater demand.

WASHINGTON AND OREGON.

GENERAL CONSIDERATIONS.

The coasts of Washington and Oregon, from Cape Flattery to the California boundary line, have a total length, due north and south, of about 383 nautical miles, reaching, therefore, through nearly 6½ degrees of latitude. The examination of this region by the steamer *Albatross* was begun in September, 1888, and was continued at intervals until in October, 1889, when it was practically completed. Since that time, however, some additional observations have been made.

As in the Alaskan region, it has been necessary to spend most time in determining the contour and general characteristics of the bottom, as very few soundings had previously been made beyond a depth of 50 fathoms, and only comparatively limited areas in more shallow water had been surveyed. The regular hydrographic work of the *Albatross* consisted in running parallel lines of soundings seaward from the coast, at intervals of 5 to 10 miles, and generally into depths of 200 or more fathoms, thus serving to develop the entire width of the continental platform to its abrupt outer edge. As the bottom fishing-grounds are mostly confined within a depth of 100 fathoms and rarely extend beyond a depth of 200 fathoms, the survey made here by the *Albatross* has been sufficiently comprehensive to meet all the requirements of the fishery interests in that respect, although in some places more detailed examinations would be desirable. Wherever the nature of the bottom or previous information indicated the occurrence of fishing-grounds, the sounding stations were run more closely together, and the amount of time spent in determining their contours and conditions was proportioned to their importance.

The width of the continental platform varies considerably at different places along the coast. At Cape Flattery the 100-fathom line is 40 miles from shore, while at Cape Johnson, 26 miles further south, it is distant only 18 miles. Off Grays Harbor the distance is 30 miles; off Willapa Bay, 20 miles; off Cape Disappointment, at the mouth of the Columbia River, 15 miles; at Tillamook Rock, Oregon, 27 miles, and at Cape Lookout 11 miles. From this point the platform gradually broadens out, attaining a width of 35 miles off the Siuslaw River, in the region of Heceta Bank, immediately south of which it is abruptly constricted to about 14 miles, becoming reduced to 7 miles at Orford Reef and 12 miles at the California State line.

The superficial area of this platform within the 100-fathom line has been estimated at about 3,700 square miles for the coast of Washington and about 4,750 square miles for the coast of Oregon.

The soundings off Cape Flattery were irregular and suggest the existence of submarine ridges lying parallel with the coast. A very elongate crescent-shaped depression, having depths of 100 to 200 fathoms, extends southward from the mouth of the Strait of Fuca a distance of some 20 or more miles, being distant from the coast from 8 to 12 miles. Thence to Yaquina Head, Oregon, the slope is regular, except in the region of the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms were found. Below Yaquina Head the platform attains its greatest width south of Cape Flattery, the somewhat triangular area which occurs there being occupied at its southwestern extremity by Heceta Bank. Further south the soundings are regular, but the depths increase more rapidly from the shore outward. The bottom consists generally of fine sand in the shallower water, changing

to mud farther offshore, although sand was also found at times in considerable depths. On the fishing-banks its character is variable, as described elsewhere.

Dredging and fishing trials were made at frequent intervals down the coast as far as Orford Reef, Oregon, leaving a distance of about 48 miles between that place and the State line, over which no fishery investigations have yet been made; but the continental platform is there very narrow.

There are very few defined fishing-grounds on the coasts of Washington and Oregon, and those which occur are of small extent. The largest and most important one lies about 11 miles northwesterly from Cape Flattery, and has a total area of about 1,100 square miles. Another, covering only about 110 square miles, is situated off the coast between Grays Harbor and Willapa Bay. A still smaller bank or rocky patch is located about 19 miles southwesterly from Yaquina Head; its area has been estimated at 40 square miles. Heceta Bank, lying off the Siuslaw River, is next in importance to Flattery Bank, having an extent of about 600 square miles.

The small extent of the banks, however, does not indicate a scarcity of fishery resources, as fishes of excellent food quality were found to be pretty generally distributed over the surface of the platform throughout a large part of the region, as described further on. In the immediate vicinity of exposed rocks lying near the coast, which are inhabited by sea lions, fishes were noticed to be rare if not entirely absent in most cases, Orford Reef, however, presenting a notable exception in this respect.

The halibut and the true cod (*Gadus morrhua*) are the species which have been most eagerly sought for by the fishermen along these coasts, but no traces of the latter were discovered by the *Albatross*. The halibut, however, ranges as far south as Monterey, Cal., although it has nowhere been found sufficiently abundant to afford the basis for a special fishery except on Flattery Bank. Scattering specimens were taken by the *Albatross* off Flattery Rocks, off Tillamook Rock, and on Heceta Bank, but the resources of this bank have not yet been fully tested. The species has also been recorded from off Cape Mendocino. The fact that the Indians south of Cape Flattery do not include the halibut among their supplies of food may be regarded as additional evidence that this fish will not be found in any numbers, near the shore at least, within this region.

Several species of rockfish (*Sebastodes*) were abundant upon the banks as well as upon the sandy bottom of the platform. Flounders were taken everywhere, but were most plentiful between depths of 50 and 100 fathoms. A number of species were discovered, some of which are of excellent food quality, and they will offer strong inducements for the introduction of beam-trawl fishing whenever a market has been established for them. Cultus-cod (*Ophiodon elongatus*) were obtained on all the banks and on Orford Reef. Black-cod (*Anoplopoma fimbria*) of good size inhabit the deeper waters, while smaller individuals, together with the ling or Pacific whiting (*Merlucius productus*), occur in moderate depths. Large red edibles hrimps were also frequently captured in the beam trawl; they are distributed through a considerable depth of water.

The principal obstacle at present to the development of extensive sea fisheries on the outer coast of Washington and the coast of Oregon is the lack of markets for disposing of the catch. The scarcity of good harbors is also a very serious inconvenience, and as those which do exist are encumbered with bars, they can be entered in bad weather only with much difficulty. Although gales are of rare occurrence during

the summer, still the coast winds blow constantly from the northward, maintaining a boisterous sea and strong currents. During the winter southeasterly storms are frequent.

List of the more abundant food-fishes taken by the Albatross on the coasts of Washington and Oregon with the beam trawl and hand lines.

[Prepared by Charles H. Townsend.]

Hippoglossus hippoglossus, Halibut.
Atheresthes stomias, Halibut-flounder.
Microstomus pacificus, Deep-sea sole.
Glyptocephalus zachirus, Long-finned sole.
Citharichthys sordidus, Flounder.
Hippoglossoides jordani, Flounder.
Hippoglossoides exilis, Flounder.
Psettichthys melanostictus, Flounder.
Parophrys vetulus, Flounder.
Isopsetta isolepis, Flounder.
Lepidopsetta bilineata, Flounder.
Sebastodes ruber, Red rockfish.
Sebastodes pinniger, Orange rockfish.
Sebastodes flavidus, Yellow-tail rockfish.
Sebastodes rosaceus, Rockfish.
Sebastodes elongatus, Rockfish.
Sebastodes melanops, Rockfish.
Sebastodes paucispinis, Rockfish.
Sebastodes nebulosus, Rockfish, and other smaller species of the same genus.
Anoplopoma fimbria, Black-cod.
Ophiodon elongatus, Cultus-cod.
Merlucius productus, Whiting.
Microgadus proximus, Tomcod.

Large rays and skates, of several edible species, were common. Anchovies and smelts were taken in the beam trawl when used near shore, while in the deeper water beyond the margin of the platform the redfish (*Sebastolobus*) was dredged in abundance. The flesh of the last-named species is rather soft, but edible.

WASHINGTON.

The Straits of Juan de Fuca and Puget Sound.—Only incidental observations have been made in these waters, either while passing through or while in port. Brief accounts of the fisheries in the vicinity of Seattle, Port Townsend, and Victoria will be found in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

The beam trawl has been used at only four stations, two (Nos. 2864, 2865) in the extreme eastern part of the straits, and two (Nos. 3067 and 3068) off Dwamish Head, near the city of Seattle. The former trials were made on September 6, 1888, in depths of 40 and 48 fathoms, but no fishes of economic value were secured. The latter were made on June 8, 1889, in depths of 82 and 135 fathoms, the bottom consisting of green mud. Among the specimens obtained were three species of flounders, hake, skates, several ratfishes (*Chimæra*), shrimps, starfishes, and sea-anemones, but not many of any kind.

In the evening of September 24, 1888, the halibut trawl was set off Kalhsla Point, outside of Neah Bay, the inner end being in 20, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on being hauled 24 dogfish and 2 skates comprised the entire catch. Halibut and black-cod are sometimes taken in close proximity to Neah Bay earlier in the season. The latter species is never abundant there, but during some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food. On October 19, following, a cod trawl was set for half an hour in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe, or black-cod, which had been reported to occur there, but only dogfish were captured, about 40 specimens in all.

Mr. Alexander states that—

> There are a few fishermen about Port Townsend and Victoria who fish for halibut and dogfish the greater part of the year. One of these, Mr. Isaac Bakman, with whom I conversed, stated that he did not think that halibut were ever abundant enough in the Straits of Fuca to warrant vessels of large size engaging in the business. In April, 1888, Mr. Bakman secured in different parts of the straits 4,500 pounds of halibut, for which he received from 2 to 3 cents per pound. These spring fish have been very scarce, and not enough have been caught to pay expenses.

During the winter of 1888–89, three men were fishing for cod in Puget Sound with gill nets and trawl lines. No large quantities of these fish were caught, but many flounders and a few halibut were taken on the trawls. The cod are obtained in all depths from 5 fathoms downwards, the deepest water in which gill nets have been set being 150 fathoms, off Quartermaster Harbor, near the head of Puget Sound. In this region both the *Gadus morrhua* and the cultus-cod (*Ophiodon elongatus*) are known under the name of cod.

Flattery Bank.—This bank, which constitutes one of the most important fishing-grounds on the Pacific coast south of British Columbia, is located to the northwestward of Cape Flattery, on the northern side of the deep-water area (from 100 to 200 fathoms) at the entrance to the Strait of Juan de Fuca. It is mostly confined within the 50-fathom curve adjacent to the coast of Vancouver Island, and lies directly off the entrance to Nitinat Lake, but it is also continuous with that part of the continental platform inside of the 100-fathom curve which skirts the outer coast of Washington, although depths of nearly 100 fathoms intervene. Flattery Bank has long been resorted to by the Indians, but, while large quantities of halibut and of other fishes have been taken from it in times past, the first extensive commercial fishery there was attempted about 1888.

As the hydrography of the bank had previously been determined with sufficient accuracy for fishery purposes, the investigations of the *Albatross* were limited for the most part to dredging and fishing trials. The first visit was paid to it in September, 1888, the inquiries being begun on the southeastern part of the bank, nearest Cape Flattery, and being carried thence to the neighborhood of Barclay Sound, Vancouver Island. The second and last examination was made in June, 1889. The entire area of the bank has not yet been surveyed and its extreme limits are, therefore, still unknown. The depths may be said to range from 27 to about 75 fathoms. The bottom varies exceedingly in character, consisting of rocks, sand, mud, and shells, and in some places being very rough and irregular. It supports a very rich fauna, which fits it especially as a feeding-ground for fishes.

Capt. Tanner assigns to this bank a total area of about 1,100 square miles. The least depth of water, 27 fathoms, was found at its southeastern extremity, 11 miles W. by N. (magnetic) from Cape Flattery light-house. Halibut occur most abundantly on the same part of the bank, over an exceedingly rough, rocky bottom, having an area of about 35 square miles. From early in the spring until the middle of June this species can be obtained on Flattery Bank in paying quantities, but later in the season dogfish and sharks strike in, driving a majority of the edible fishes away.

The dredging and fishing trials by the *Albatross* were as follows:

Three dredging stations (2873 to 2875, inclusive) were made on September 24, 1888, at distances of 10 to 12 miles northwesterly from Cape Flattery, the depths ranging from 27 to 40 fathoms, and all varieties of bottom being found. The first trial was with the beam trawl in 40 fathoms, but it caught upon the bottom and was badly

wrecked. The tangles were then used successively in depths of 27 and 40 fathoms, with good results. A trawl line, baited with salt salmon and red rockfish, was set for three hours in about the same position on rocky bottom, depth 40 fathoms, the catch consisting of 4 halibut, 2 sharks, 4 red rockfish, and 2 starfishes. The average weight of the halibut was 47¾ pounds; three were females and one was a male; they were all white. It is said that gray halibut are seldom found in these waters.

On September 25 work was continued in nearly the same locality as on the previous day. The beam trawl was cast at station No. 2876, 2 or 3 miles northeasterly from stations 2873 to 2875, and the trawl line, baited with salmon, red rockfish, and fresh halibut, was set at the same time. The depth was 59 fathoms, and the bottom consisted of black sand and mud. The beam trawl dragged but a few yards, when it caught on a rocky patch, parted the bridle stops, and came up tail first. It was, however, a successful haul, and many specimens were found in the net. The tangles were subsequently hauled over the same ground (station 2877) with good results, giving evidence of the richness of the bottom. The towing net, which was frequently used in this region, however, gave very little evidence of surface life. The halibut trawl remained on the bottom three hours, and the catch consisted of 2 halibut, 1 red rockfish, and 9 dogfish, the average weight of the halibut being 55 pounds.

On the afternoon of September 25 the trawl line was set and the dredge lowered in 66 fathoms, gravel and pebbles (station 2878), S. 48° W., 16 miles from Cape Beale light-house, on the southern side of the entrance to Barclay Sound, Vancouver Island. The contents of the dredge, consisting for the most part of small mollusks, did not bear evidence of a rich bottom. The same bait was used upon the trawl line as in the previous trial, and the capture after two hours' time consisted of 2 black-cod, 15 dogfish, 2 common sharks, and 2 ground sharks. Only a small quantity of surface organisms was taken in the tow nets.

Early on the following day two dredge hauls were made at stations 2879 and 2880, 27 miles N. 79° W. from Cape Beale, in 34 fathoms, rocky bottom, with about the same results as at station 2878, the bottom not being rich so far as the contents of the dredge indicated. A trial with the halibut trawl in the same locality, lasting about three hours, afforded 1 halibut weighing 25 pounds, 2 sharks, and 3 dogfish.

At station 2881, in the same neighborhood, but much nearer the coast, Cape Beale bearing S. 26° E., distant 26 miles, the dredge was cast in 24 fathoms, on a rough bottom, with fine gray sand in places. The results were not favorable to good fishing. The trawl line set in the same position took 1 halibut weighing 15 pounds, 5 dogfish, 1 shark, and 1 skate. The trawl, when it came up, was covered with "slime," which was contrary to expectations, as the dredging which preceded it indicated clean bottom.

September 27 and 28 were spent in Barclay Sound, and the following day a skate of halibut trawl was set in 60 fathoms of water, sandy and rocky bottom, 22 miles S. 14° E. from Cape Beale. The trawl was kept down about two hours, with the result of capturing 16 dogfish, 1 beshowe or black-cod, 1 cultus-cod, and 3 small halibut. This spot would probably be a good one for halibut earlier in the season, before the dogfish set in, and is convenient to the Straits of Fuca. It requires examination in the spring or winter to determine its merits.

On June 14, 1889, the trawl line was set on Flattery Bank, in a depth of 31 fathoms, Cape Flattery bearing E. by S. ½ S. and Cape Beale NW. by W. The bottom consisted of gravel, broken shells, and rocks. The tide was running ebb, but not strong, and a dense fog prevailed. The trawl was left down about three hours, at the end of which time the following fish were taken from the hooks: 8 halibut, averaging 35 pounds each; 10 red rockfish, averaging 10 pounds each; 2 orange rockfish; 1 sea trout; 1 cultus-cod, weighing 19 pounds; 1 skate, and 45 dogfish. The bottom was so rough that many of the hooks caught upon it while hauling, and toward the end the ground line parted, but none of the gear was lost. One small halibut and about a dozen dogfish were caught with hand lines from the small boats tending the trawl, and during the same time one halibut weighing 93 pounds and several red rockfish were taken by the same means from the deck of the *Albatross*. A native canoe with four Indians, which came alongside during the day, contained 15 small halibut which had been captured with the primitive wooden hooks.

Barclay Sound, Vancouver Island.—On September 26, 1888, the *Albatross* anchored in Barclay Sound, where she was detained by fog for two days, enabling the naturalists to make some interesting observations upon the natural history of the region. A rich and diversified fauna was discovered, and many specimens were collected. There are not many beaches adapted to seining, but some were found on which a large variety of shore fishes was obtained. Salmon were seen darting about in every direction. They are said to be very plentiful at the head waters of the sound, where they enter the creeks and inlets to spawn. A few large specimens were caught by trolling. A cod trawl, baited with halibut and salmon, was also set one evening in a depth of 17 fathoms, and allowed to remain down over night. The next morning 28 dogfish and 1 red rockfish were found upon the hooks.

Notes on the Halibut Fishery.—The following notes on the halibut fisheries located off the coast of Washington or tributary to its ports are such only as have been furnished through the medium of the *Albatross*, and are here given to illustrate in a practical manner the resources of the grounds. For further information on the same subject reference should be made to the Bulletin for 1888, pp. 62–64, and the Annual Report for 1888, pp. 260–266.

Until within a few years the halibut fisheries of Washington have been almost exclusively the property of the Indians resident upon certain portions of the coast. Beginning in 1888, however, strenuous efforts have been made to establish an extensive commercial fishery, the final outcome of which is still to be decided. The promoters of this enterprise have, unfortunately, encountered many obstacles in the matter of obtaining ice and of shipping their catch to market, which, tending to restrict their operations, has prevented a thorough testing of the grounds; and yet, within certain limits, good results have already been accomplished.

The Indians of Neah Bay visit Flattery Bank daily during the halibut season, whenever the weather permits, and also fish on less important grounds closer at hand; they bring in considerable quantities of halibut, cultus-cod, and red rockfish; herring, smelt, and squid, as well as halibut and red rockfish, are used as bait.

The first vessel fishery appears to have been started in 1888 by two well-equipped schooners, the *Mollie Adams* and the *Oscar and Hattie*, which had recently arrived from Gloucester, Mass. After completing a successful sealing voyage in the spring of that year, the *Mollie Adams* made four trips in quick succession to Flattery Bank, securing, in all, 145,000 pounds of halibut, which were landed at Seattle. The stock amounted to $3,000, the crew receiving shares of $75 each. The expenses were high, however, $15 per ton having been paid for ice on the first trip, although the price was subsequently reduced to $8. During the same season the *Oscar and Hattie* obtained one fare of 50,000 pounds of halibut on Flattery Bank; the fish were landed at Tacoma. But little or nothing was realized from the trip.

In the fall of 1888, several fishermen, well equipped with dories, trawls, etc., established a camp in the vicinity of Neah Bay, and fished continuously throughout the following winter on Flattery Bank and directly off Cape Flattery. Mr. Moor, one of the members of this party, who came to the Pacific coast in the schooner *Mollie Adams*, has furnished a synopsis of the winter fishing. They first set trawls on November 23, 1888, and from that date up to January 7, 1889, succeeded in landing 2,076 pounds of halibut and 244 pounds of cultus-cod. The average weight of the halibut was 37 pounds, and of the cultus-cod 24 pounds. After January 7 little was done, owing to the scarcity of fish and bait and the prevalence of stormy weather. Mr. Moor does not think it advisable to send vessels to Flattery Bank earlier than the 1st of March nor later than the 1st of September. He thinks that halibut are abundant from March to June, but they do not occur in the incredible numbers which have been reported from time to time.

In November, 1888, Capt. Silas Calder, then of the *Mollie Adams*, made a series of trials for halibut on Flattery Bank, without, however, securing a single specimen. He is of the opinion that vessels could obtain good fares during a few months of each year, and might find the business profitable if there were a market for the catch.

The yacht *C. H. White*, of San Francisco, chartered in the fall of 1888 by Messrs. Louch and Johnson, of Seattle, obtained 100,000 pounds of halibut during three trips to the same bank. About 60,000 pounds were shipped fresh to New York, the remainder being smoked.

Several interesting trips at different seasons of the year have also been made farther north than Flattery Bank. While the results accomplished in that direction are not sufficient to serve as a basis for positive conclusions regarding the abundance of halibut in the places visited, which undoubtedly varies at different times of the year, they are at least suggestive and worthy of notice in this connection.

On July 24, 1888, the *Mollie Adams* left Seattle with the object of testing the bottom along the coast of British Columbia. Trials were made in several localities, but few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in greater abundance and of larger size than on Flattery Bank. A few of those obtained were estimated to weigh over 300 pounds apiece. Fishing was carried on in depths of only 30 to 45 fathoms, the fish taking the bait so rapidly that the trawls were left down only during the day time. The work continued until September 8, with slight intermissions on account of stormy weather. About half the halibut secured were large enough for fletching, the remainder being used as bait or thrown away. The total fare carried to Seattle amounted to 150,000 pounds. After deducting all expenses the crew received $175 each, or at the rate of $9 a day for 19 days' fishing.

On January 3, 1889, the schooner *Oscar and Hattie* sailed from Port Townsend on a similar errand, but proceeded directly to Sitka, Alaska, and began fishing on the inshore grounds adjacent to Baranof Island, where halibut had been reported as very abundant. Work was continued, as the weather permitted, until March 1, but not enough fish were taken to keep the hooks baited. The vessel was subsequently shifted to deeper water off shore, but without securing any better success. Early in March she proceeded down the coast, fishing until June 1 in the neighborhood of the Queen Charlotte Islands, Cape Scott, and Hecate Channel. Halibut were more common in these localities, but nowhere abundant, and it was often necessary to shift position twice a day. A fare of 140,000 pounds was finally secured. The fish averaged about 65 pounds each in weight, and on the British Columbian coast none were captured in greater depths than 45 fathoms. Capt. Calder, of the *Oscar and Hattie*, states that while off Sitka he encountered many heavy gales, which did much damage to the rigging and fishing gear, but there was no snow or ice to contend with, as would have been the case on the North Atlantic coast at the same season.

The schooner *Rose Oleson*, of Astoria, chartered by parties in Port Townsend, made one trip to the vicinity of Cape Scott, at the northern end of Vancouver Island, beginning the cruise during the first part of April. She was gone five weeks, and obtained a fare of 15,000 pounds.

Cape Flattery to Grays Harbor.—The hydrographic examinations along the coast of Washington were begun off Cape Flattery on September 19, 1888, and were completed in the latitude of Columbia River on the 13th of October following. Dredging and fishing trials were made in the same connection and also at subsequent periods. The first line of stations was commenced in 82 fathoms, 10 miles S., 68° W., from Cape Flattery light, and was carried 65 miles S., 68° W., soundings being made at intervals of 5 miles to develop banks reported to exist 60 and 75 miles from the cape. The depths were irregular for 30 miles, then increased uniformly to 768 fathoms at the former and 1,239 fathoms at the latter position. The occurrence of the banks in the places indicated was therefore disproved.

Three dredgings, all with the beam trawl, were made in the vicinity of Flattery Rocks and between there and Cape Flattery on September 20 and 24, 1888. The first was at station No. 2866, 19 miles S., 40° W., from Flattery light-house, 171 fathoms, gray sand; the second at station 2867, 17 miles S., 23° W., from Flattery light, 37 fathoms, fine sand; the third at station 2872, 8 miles S., 40° W., from the same light-house, 38 fathoms, gray sand.

Near station 2867 the halibut trawl, baited with salt salmon, was set at 3 p. m. and hauled at 5 p. m., securing 8 sharks, 2 dogfish, and 1 halibut, the latter weighing 140 pounds and measuring 5 feet 9 inches in length. A few hand lines were also tried in the same locality, 1 red rockfish and several dogfish being taken by that means. A skate of halibut trawl, baited with salt salmon and red rockfish, was likewise set in the position of dredging station 2872, but only 2 sharks and 1 starfish were obtained. In the spring the Indians fish for halibut in this locality, but no satisfactory information regarding their abundance there has yet been obtained.

On September 21, 1888, the beam trawl was used at station No. 2868, off Cape Johnson, and station No. 2869, off Destruction Island, in depths of 31 and 32 fathoms, respectively, the bottom consisting of sand. At the former station tomcod, flounders, red rockfish, and 1 black-cod were taken in the beam trawl. A trawl line, baited with salt salmon and clams, was set in the same position, but very few of the baits were disturbed, only 2 red rockfish, 3 dogfish, and 1 skate being captured. Trial lines from the deck of the steamer afforded no results.

The following June dredging operations were conducted off this part of the coast, to the west and southwest of Destruction Island, in depths of 178 to 877 fathoms. That work has been reported upon by Capt. Tanner as follows:

> Passing Cape Flattery we steamed offshore until 7:45 a.m., on June 28, 1889, when the trawl was cast in 760 fathoms (station 3069), green mud. A heavy westerly swell caused the ship to tumble about so much that it was difficult to carry on our work, and finally resulted in parting the bridle

stops, causing the net to come up tail first, and practically empty. There were, however, a few pennatulas, starfish, holothurians, etc., adhering to the net. Four more hauls were made during the day in 636, 685, 584, and 477 fathoms (stations 3070, 3071, 3072, 3073), the bottom being uniformly of green mud. The wind and sea increased with heavy rain squalls, making it necessary to use the small trawl the latter part of the day, the weather being too boisterous to handle the large one with safety. The results were very satisfactory and, it being practically new ground, many unrecognized specimens were taken besides others that were familiar, among them being several species of flounders, deep-sea sole, deep-water redfish (*Sebastolobus*), red rockfish, macruri, chimæras, and hagfish. Among the invertebrates were shrimp, hermit-crabs, annelids, sea-urchins, holothurians, ophiurans, starfish, sea-anemones, crinoids, pennatulas, etc.

The weather was partially overcast on the 29th, with moderate winds and heavy westerly swells. Three hauls of the trawl were made in 877, 859, and 178 fathoms (stations 3074, 3075, 3076), green mud, with excellent results. Among the fishes recognized were the deep-water redfish, flounders, sole, red rockfish, and a single specimen of black-cod taken in 859 fathoms, the greatest depth in which they have been found. Among the invertebrates were holothurians, sea-urchins, starfish, ophiurans, sea-anemones, pennatulas, hermit-crabs, shrimp, annelids, an octopus, etc., the greatest amount of life being found in about 200 fathoms.

The stations occupied on the 28th and 29th extended our explorations from the shore to 877 fathoms, and gave us a very good representation of the marine fauna occupying the various depths. A notable feature in the hauls made during the trip was the absence of mud in the trawl net when it reached the surface, although soft green mud was reported at every station. This would seem to indicate that the bottom was composed largely of very fine sand, rather than mud, or at least the absence of clay. A few whales were seen, but with this exception no surface life was observed. The black-footed albatross or gony and an occasional petrel were the only birds seen, except near the land, where gulls were plentiful.

Beam trawl stations No. 3343 (516 fathoms) and 3344 (831 fathoms) were also made in the same region as the above, on September 21, 1890.

Grays Harbor to the Columbia River.—A report of Indian origin having indicated the existence of a small bank off the coast of Washington between Grays Harbor and Willapa Bay, a careful examination of the region was made during the progress of the hydrographic work in September and October, 1888. Such a bank was discovered and its principal features have been defined; it has been named Willapa Bank. It is about 20 miles long, northeast and southwest, and about 12 miles in extreme width, having a total area of about 110 square miles. Its eastern extremity, on which there is 42 fathoms, rocky bottom, lies 16 miles southwest (magnetic) from Point Chehalis, on the southern side of the entrance to Grays Harbor, and 23 miles W. by S. (magnetic) from Toke Point light-house at the northern end of Willapa Bay. The soundings are quite regular, but the bottom alternates in character between rocks, gray sand, and mud. The dredgings and trials for fish on this bank proved more successful than any previously made south of Cape Flattery, and there is little doubt that at the proper season good fishing would be found in this locality.

On September 23, 1888, the beam trawl was used at station 2870, on the southern edge of the bank, in 58 fathoms, rocky bottom. A very rich fauna was discovered, black-cod, red rockfish, tomcod, and shrimps also being taken by this means. On a trawl line set in the same position 10 red rockfish, 2 black-cod, and 4 sharks were captured. Three red rockfish were likewise caught with hand lines from the ship at the same time. The last-mentioned species was the most abundant one at this season. Hand lines were subsequently tried for 15 minutes about 10½ miles off Cape Shoalwater, but without success. On the same day station 2871, with the beam trawl, was made about 45 miles off the entrance to Grays Harbor, in a depth of 559 fathoms, brown ooze, with the result of obtaining many deep-water forms.

The investigations on this bank were resumed on June 7, 1889, the day being spent in dredging and fishing trials. Stations 3046, 3047, and 3048, in 48 to 52 fathoms, were made with the beam trawl, the bottom consisting of rocks in some places and in others of fine gray sand, and flounders, tomcod, and shrimps being thus secured. A trawl line was set for two hours at the last station, one end being in 52 fathoms, the other extending into 60 fathoms, but on being hauled only 4 red rockfish, 4 dogfish, 2 skates, and several starfish were found upon the hooks. The tide was running too strong to employ hand lines successfully from the small boat, but a few rockfish were taken by that means from the steamer.

Beam-trawl station 3049 was in 43 fathoms, fine sandy bottom, about 13 miles to the southwestward of the entrance to Willapa Bay, the catch comprising flounders, tomcod, and shrimps, as on the bank farther north. On June 13, 1889, the beam trawl (No. 3066) was again used about 7 miles south of the above station in a depth of 55 fathoms, sand and mud, flounders and skates being the only fishes taken.

OREGON.

Columbia River.—The fisheries of the Columbia River have been discussed in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

Off the Columbia River.—The region off the mouth of the Columbia River was examined chiefly in October, 1888. On the 13th of that month three nearly parallel lines of soundings were made between the latitude of Cape Disappointment and that of Tillamook Rock, extending offshore distances of 32 to 36 miles, and into an extreme depth of 601 fathoms. The northernmost line, which was directly off the mouth of the Columbia River, showed depths two or three times greater than in corresponding positions on adjacent lines 7 or 8 miles distant, both to the north and south, the submarine trough thus indicated being probably the ancient bed of the Columbia River. Trials were made with the beam trawl and trawl line at station No. 2882, about 27 miles off the mouth of the river, in a depth of 68 fathoms, gray sandy bottom. By means of the former a number of flounders, red rockfish, and black-cod were secured, but only 1 black-cod and 4 dogfish were taken upon the latter. Southwest of Cape Disappointment station 3065 was occupied on June 13, 1889, the depth being 27 fathoms and the bottom consisting of fine black sand. Flounders, tomcod, and shrimps were captured in the beam trawl, but nothing was obtained by the use of hand lines.

The existence of fishing-banks from 50 to 60 miles off this part of the coast, which had been reported in Astoria, was entirely disproved by the investigations of the *Albatross*, very deep water occurring in the positions indicated. It is possible that this rumor had its origin in Heceta Bank, which, however, is located very much farther south.

According to Capt. Tanner:

> The sea fisheries off the Columbia were commenced a few years since with a small schooner, which operated a 40-foot beam trawl over the ground between Cape Disappointment and Shoalwater Bay. The vessel being found unfit for the purpose, the steamer *Dolphin* was built and made 40 trips between April and October, 1887, but she also proved a failure. Her catch was fairly good, and had she been able to market her fish promptly the venture would have turned out profitably. The various fish taken by the *Dolphin* were classified as sole, flounders, hake, cod, rock-cod, and halibut.

The "cod" mentioned were probably not the *Gadus morrhua.*

Off Tillamook Rock.—This rock is situated off Tillamook Head, about 16 or 17 miles south of the mouth of the Columbia River. As halibut had been reported from the adjacent waters, a careful examination was made of its surroundings, one visit having been paid to the region in October, 1888, and another in June, 1889. On the first visit the bottom was tested in several places off the northern side of the rock, in depths of 29 to 30 fathoms, by means of the dredge. It consisted of hard gray sand, but only a comparatively small amount of life was obtained. At the same time a trawl line was set near the can-buoy off the northern end of the rock, one end lying in 18 fathoms, the other in 25 fathoms, the bottom being rocky. The total catch consisted of only 7 dogfish. This experience, together with the results of subsequent trials during the same season, showed that, in the fall, the coast of Oregon, like that of Washington, is seriously infested with sharks and dogfish, which greatly interfere with successful fishing.

Somewhat better success was met with the following June, when the *Albatross* proceeded to Tillamook Rock in company with the light-house steamer *Manzanita*. Acting upon the advice of the commander of the *Manzanita*, the trawl line was set so as to cover as much as possible of the ground from which the capture of halibut had been reported, one end being placed close to Tillamook Rock and the other near the shore of the mainland. After remaining down two hours, the catch comprised 1 halibut weighing 25 pounds, 1 large skate, and 1 red rockfish. Hundreds of starfishes were also attached to the hooks and proved a great annoyance. In the meantime the *Manzanita*, at her moorings alongside the rock, obtained 3 halibut and 2 ground-sharks by means of hand lines, but with the same appliances only a few red rockfish were taken by the *Albatross*, although trials were made in numerous places.

Four beam-trawl stations (Nos. 3060–3063) were occupied in different positions about the rock, during the same day, in depths of 23 to 44 fathoms. The bottom consisted of mud at one station in 28 fathoms, and of fine sand at the others. Among the specimens secured were 8 species of flounders, hake, tomcod, sculpins, shrimp, smelt, crabs, and an octopus.

The grounds about Tillamook Rock to which halibut are likely to resort appear to cover a very limited area, which may be regarded as suitable for boat fishing with hand lines. Scattering halibut will probably be found there during a large part of the year. The grounds are too small, however, and the fish too scarce to offer any inducements for vessel fishing or the use of trawl lines. Many of the so-called halibut recorded from this region are said to be a very different kind of flatfish, the *Atheresthes stomias*, which also goes by the name of "turbot" in Astoria.

Beam-trawl station No. 3064 was about 9 miles northwest from Tillamook Rock, in 46 fathoms, fine gray sand and gravel. Although the same character of bottom fauna as occurs in corresponding depths about the rock was discovered in this position, trials with hand lines proved entirely unsuccessful.

Off Cape Falcon.—Cape Falcon, or False Tillamook, is about 11 miles south of Tillamook Head. Several soundings were made in the vicinity of Falcon Rock on September 7, 1889, and hand lines were tried in the same connection. A fine salmon and 2 orange rockfish were the only specimens taken. The work was continued at short intervals down the coast, but the ground was not found to be especially productive for hook-and-line fishing. A strong tide was running at the time and it is possible that this circumstance may partly account for the scarcity of fish, as is known to be the case elsewhere. On many of the spots over which the vessel drifted flounders were captured on the hand lines, indicating that the beam trawl could be used successfully in this region.

At station 3089, about 5 miles south of the cape, in a depth of 20 fathoms, fine gray sand, the beam trawl brought up between 800 and 900 flounders, besides 12 tomcod and a quantity of shrimps. Eleven orange rockfish and 2 flounders were taken with hand lines in the same locality. The beam trawl was also used at station 3090, about 8½ miles southeasterly from the cape, in a depth of 62 fathoms, fine gray sand. The catch included 3 species of flounders, rockfish, whiting, and shrimps. Station 3345 was in a depth of 759 fathoms, a little south of east of Cape Falcon.

Off Cape Meares.—In approaching this cape, which lies about 16½ miles south of Cape Falcon, a cast of the beam trawl was made at station 3091, about 15 miles west of the cape, in a depth of 87 fathoms, green mud. Five red rockfish, 4 species of flounders, represented by about 100 specimens, half a dozen squid, and a peck of prawns were secured. Station 3092, also with the beam trawl, was about 4 miles off the cape, in the same direction, depth 46 fathoms, the bottom consisting of broken shells, 4 species of flounders and several crabs being obtained. By the use of hand lines, 1 red rockfish was taken in the same position; 14 red rockfish were quickly captured nearer the cape in a depth of 25 fathoms; and 24 rockfish of several species, together with 1 cultus-cod, were secured in 18 fathoms in the vicinity of Arched Rock, about 6½ miles north of the cape.

A series of trials with hand lines was made from the dory about Three Arch Rocks, some 2 miles south of Cape Meares, while the *Albatross* was employed farther offshore, but although the work was conducted with as much thoroughness as the time permitted, the fishermen met with no success. The first trials were on the northern side of the rocks, but after shifting to the southern side, the cause of the scarcity of life in the immediate vicinity of the rocks was apparently discovered in the abundance of sea lions, hundreds of which were hauled out in all sheltered places where they could receive the warmth of the sun's rays.

About 1½ miles southwesterly from these rocks, in a depth of 21 fathoms, rocky bottom, 1 red rockfish and 1 cultus-cod were taken on the lines; and again, 3½ miles farther south, or 2⅝ miles north of Cape Lookout, in a depth of 18 fathoms, sandy bottom, 1 flounder was taken by the same means.

Beam-trawl station 3346 was west of Cape Meares, in a depth of 786 fathoms.

Off Cape Lookout—A thorough search of the bottom was made close inshore in the vicinity of Cape Lookout, beginning about 3 miles north of the cape and ending some 3 or 4 miles south of it, but, although the hand lines were tried in 15 different positions, not a single fish was taken. About 2 miles southwest of the cape, however, in a depth of 39 fathoms, 2 orange rockfish, 1 salmon, and 1 flounder were secured. Beam-trawl station 3093 was about 4½ miles west of the cape, in a depth of 57 fathoms, fine gray sand, but only negative results were obtained there as regards the capture of fish, either in the net or with the hand lines. The abundance of sea lions along the coast might account for the scarcity of fishes in close proximity to the shore, but not in deeper water.

Nestuggah Bay to Siletz Bay.—Attention having been called to a supposed bank off Nestuggah, Oregon, where the genuine cod was reported to abound, a careful search of the region was made by the *Albatross* in the early part of September, 1889. It was said to be located about 10 miles from land and to have a depth of 12 fathoms. Soundings made at frequent intervals off the bay, and for some distance to the north and south, showed 15 fathoms about 1 mile from shore, from which point the depths increased regularly to 70 fathoms, at a distance of 8 to 10 miles, or in the position of the alleged bank. The bottom consisted of fine gray sand, from which the customary varieties of coast fishes were obtained, but no specimens of cod. A depth of 12 fathoms will be found nowhere in this region except within a fraction of a mile of the land and well within the sound of the surf.

Thirteen trials with hand lines were made between Cape Lookout and Siletz Bay on September 9, 1889, with the result of finding food-fishes abundant in some localities. The slight depths of water near the shore and the generally smooth bottom render fishing easy, and it may be regarded as comparatively good. The tidal currents are somewhat strong at times, but not sufficiently so as to greatly inconvenience operations. Many black-cod were taken on the hand lines off Nestuggah Bay and off Cascade Head, the other fishes consisting mainly of different varieties of rockfish, with an occasional flounder. The black-cod from these shallow waters are smaller and are also said to have a poorer flavor than those obtained from the deeper waters offshore and farther north.

The beam trawl was used at station 3059 (June 9, 1889), about 8 miles off Siletz Bay, depth 77 fathoms, muddy bottom; and at station 3347 (September 22, 1889), off Nestuggah Bay, in a depth of 345 fathoms, muddy bottom. In the former haul many flounders were secured, and also one herring and several specimens of *Octopus.*

Off Yaquina Head.—Investigations were conducted in the vicinity of Yaquina Head (latitude 44° 40′ N.) in June, August, and September, 1889. Leaving Heceta Bank at dark on June 8, 1889, a line of soundings was run to Yaquina Head, developing a maximum depth of 78 fathoms. Early the next morning the beam trawl was hauled twice (stations 3055, 3056) in a depth of 28 fathoms, fine gray sand, about 3 miles west (magnetic) from Yaquina Head, taking an abundance of several species of flounders, besides crabs and shrimps. Trials with hand lines in the same position gave negative results, but the wind was blowing fresh at the time, causing the small boat to pitch about considerably, and possibly being accountable for the poor fishing.

A station (No. 3057) was then occupied 13 miles from the head in the same direction, depth 43 fathoms, coarse gray sand. Large numbers of flounders, red rockfish and shrimps were taken in the beam trawl, and 20 orange rockfish on the hand lines. Specimens of rockfish weighing 7 and 8 pounds apiece were fairly abundant. The wind and sea having greatly increased during the morning, the *Albatross* ran in and anchored under the head, a boat party being sent out to examine the shore to the leeward of the rocks. They met with no success, however, and fishing from the steamer also proved a failure.

In the afternoon of the same day the beam trawl was used at station No. 3058, 13½ miles northwesterly from Yaquina Head, and 4 miles offshore, in a depth of 38 fathoms, coarse gray sand and shells. Several species of flounders were taken in the beam trawl, but nothing was secured by means of hand lines.

On August 30, 1889, while proceeding down the coast, a trial with hand lines was made in a depth of 28 fathoms, fine gray sand, about 12 miles southwest of Yaquina Head, and 5½ miles in the same general direction from the mouth of Yaquina Bay. The only fishes obtained were one red rockfish and two ling or whiting (*Merlucius productus*). The wind at this time was blowing fresh, however, causing the ship to drift rapidly, and making it difficult to keep the lines on the bottom.

The vessel returned to the same region on September 3, 1889, and continued the investigations to the southwest of Yaquina Head at varying distances from the land. In addition to four hauls made with the beam trawl, hand-line fishing was carried on in very many places. An exception to the customary smooth, sandy bottom was discovered in a small bank or rocky patch lying SSW. ½ W. (magnetic), 19 miles from the head, and almost directly off the entrance to Alseya Bay, from which it is distant about 14½ miles. It has been designated as Yaquina Bank. The center of the ground, so far as it has been surveyed, is in about latitude 44° 27′ 30″ N., longitude 124° 25′ W. It covers an area of about 40 square miles, the least depth discovered being 42 fathoms, and the bottom being composed of clay and mud, with frequent rocky or stony patches. Several specimens of the rock were brought up in the beam trawl. They consisted of waterworn bowlders of blue limestone, weighing from 50 to 200 pounds apiece, and evidently belonged to a drift deposit. Their surfaces were honeycombed by boring animals, and they were thickly covered with living organisms, including small cup corals, sponges, brachiopods, mollusks, annelids, ophiurans, etc. Dredging stations Nos. 3087 and 3088 were on this bank, and trials with hand lines were also made, resulting in the capture of orange rockfish and flounders, but the prevalence of stormy weather prevented entirely satisfactory results. The various species of rockfish will doubtless be found here in great abundance.

At different positions between the bank and Yaquina Head, the bottom, in depths of 28 to 46 fathoms, consisted generally of fine sand, from which many black-cod and orange rockfish, and a few specimens of whiting, flounders, etc., were secured. Flounders and prawns were taken in the beam trawl at stations 3085 and 3086, in depths of 42 and 46 fathoms, respectively, the former being about 14 the latter about 11 miles southwesterly from the head. Thirty-seven specimens of black-cod were obtained during a single drift, in a depth of 44 fathoms, about 8 miles SW. ½ S. from the head. The best fishing-grounds inside of the bank were found at distances of 6 to 8 miles offshore.

Cape Perpetua to Umpqua River.—On September 2, 1889, the beam trawl was cast in 46 fathoms, fine gray sand, at station 3084 (latitude 44° 12′ 31″ N., longitude 124° 19′ W.), about 15 miles southwesterly from Cape Perpetua, securing many flounders. By means of hand lines, 10 black-cod and 9 whiting were obtained in the same position, in the course of 45 minutes. Between this locality and Cape Perpetua, and to the northward of the cape as far as latitude 44° 20′, the hand lines were frequently employed in depths of 12 to 31 fathoms, and generally with good results, the catch consisting of red rockfish, black-cod, whiting, and flounders. One trial of 45 minutes in a depth of 31 fathoms yielded 24 whiting, 14 rockfish, and 2 flounders Specimens of the whiting were eaten by the mess and they were pronounced to be of as good quality as the red rockfish. The region about Cape Perpetua affords good advantages for small-boat fishing, the depths being slight and the bottom smooth. About 600 pounds of edible fish were obtained by the *Albatross* on the trials made during this day.

A single trial with the hand lines in 29 fathoms, off Heceta Head, on August 31, 1889, was entirely unsuccessful.

On September 10, 1889, several orange rockfish were taken on the hand lines northwesterly from the mouth of the Siuslaw River (latitude 44° N.), at distances of 3 and 11 miles from land, in depths of 30 and 42 fathoms, fine sand bottom. Beam-trawl stations 3081 and 3083 were also made off this river on September 1 and 2, in depths of

61 and 32 fathoms, respectively. An abundance of fishes, including several species of flounders and of rockfish, 2 black-cod, and a quantity of crabs and shrimps, were secured at the former, and many flounders at the latter. Nine red rockfish and 2 whiting were captured with hand lines in the last position.

Two and two-thirds miles off the Siuslaw River, in a depth of 18 fathoms, fine gray sand, 52 black rockfish (*Sebastodes melanops*) were taken with hand lines, on the latter date, in a trial lasting one hour. In 24 fathoms, yellow sand bottom, about 1½ miles farther north, the catch consisted of 5 black-cod and 8 orange rockfish. This locality is very favorable for hand-line fishing, large captures being possible in comparatively shallow water and in close proximity to the shore.

Beam trawl station 3082, on September 2, was located 4 miles from land, directly off the mouth of Ten Mile Creek which drains Tsiltcoos Lake, in latitude 43° 52′ N., 43 fathoms, fine gray sand. Several flounders were taken in the net, but nothing was caught on hand lines used in the same connection.

Several trials were made with hand lines, on September 10, between the latitude of Siuslaw River and that of Umpqua River, with the following results: In 13 fathoms, just to the north of Ten Mile Creek, nothing; in 36 fathoms, about 2½ miles off Takhenitch Creek, 1 red rockfish; in 13 fathoms, immediately south of the mouth of this creek, nothing; in 28 fathoms, about 2½ miles northwesterly from the mouth of Umpqua River, 27 red rockfish; about 2½ miles directly west of the mouth of the same river, 1 red rockfish. The duration of these trials was from 8 to 30 minutes each.

Heceta Bank.—Off Cascade Head, a short distance north of the parallel of 45° N. latitude, the 100-fathom curve is distant only about 13 miles from shore, but southward from this point the platform broadens regularly, attaining a width of 35 miles in latitude 44° N. A few miles farther south, however, it is abruptly constricted to a width of 18 or 19 miles. The southwestern part of this elongated triangular area is occupied by Heceta Bank, the only important distinctive offshore fishing-ground on the coast of Oregon. Its southern and western borders are defined by the abrupt sloping margins of the platform, but on the northern and eastern sides the bank is practically continuous with the general surface of the platform, and in those directions its precise limits have not yet been determined. The total area of the bank probably does not exceed 300 square miles. The depths range from 41 to 95 or more fathoms, and in some places they vary abruptly. Two small areas with depths between 41 and 46 fathoms occur on the extreme southwestern part of the bank, but as a rule the depths exceed 55 fathoms. A considerable part of the bank has a rocky bottom, alternating with patches of clay, pebbles, and gravel, but sand and mud are also found in places. Halibut occur on this ground, but they are not known to be abundant.

Heceta Bank was visited by the *Albatross* on October 19, 1888, June 8, 1889, and September 1, 1889, and its contour and principal characteristics have been pretty well determined. Ten dredging stations have been occupied in depths of 41 to 68 fathoms, but owing to the very rough character of the bottom the beam trawl was seldom used successfully, most reliance being placed upon the dredge and tangles, especially the latter, for obtaining specimens of the bottom life. A very rich fauna was discovered, fully equal to that of Flattery Bank, the large collection of invertebrates secured containing a great diversity of forms, among which were gorgonian, hydroid, and actinian corals, sponges, comatulæ, ophiurans, starfishes, sea-urchins, bryozoans, ascidians, etc. In this respect the region presents every requisite for an excellent fishing-bank, which it will undoubtedly prove to be when it has been more thoroughly developed.

Fishing operations were actively carried on during each visit, by means of the beam trawl where possible, and with trawl lines and hand lines, the latter being generally employed and with the best success. The variety of food-fishes obtained was quite large, including halibut, black-cod, cultus-cod, sea trout, whiting, red rockfish, and several other species of the latter group.

On October 19, 1888, the catch was small, containing only 1 halibut, weighing 10½ pounds, in addition to several specimens of rockfish and black-cod, 1 shark and 1 dogfish. Stations 2886, 2887, 2888, 2889, and 2890 were made on this day, the last one being off the southern end of the bank, in a depth of 277 fathoms.

During the morning of June 8, 1889, a trawl line baited with fresh rockfish and salt herring was set for something over two hours in the position of stations 3050, 3051, and 3052, 46 to 48 fathoms, rough rocky bottom, the tide running strongly ebb toward the southeast. Eleven red rockfish, 1 orange rockfish and 1 sea trout were taken by this means, while with hand lines from the ship the catch was much larger, consisting of 26 red rockfish, 2 orange rockfish, 4 yellow-tails, and 1 cultus-cod. In the afternoon of the same day three small boats were lowered to test the bottom with hand lines in as many places at the same time. They were anchored within half a mile of each other, in a depth of about 43 fathoms, and at the end of an hour had secured 22 red rockfish, weighing 192 pounds. Twelve additional specimens were captured from the deck of the *Albatross* during the same interval with the aid of only three lines. Just before sunset, a trial with 11 lines was made at station 3054, depth 53 fathoms, rocky bottom, on the northern part of the bank, but only 1 yellow-tail was caught. The trials made during this day seemed to indicate that better results could be obtained with the hand lines by drifting than by anchoring, the fish apparently congregating on detached rocky spots. Good fishing would continue for a time and then suddenly cease, making it necessary to seek a new ground.

September 1, 1889, was a clear day with comparatively smooth sea, and thereby offered an excellent opportunity for continuing the work. Much time was spent in attempting to determine the area of the shoaler part of the bank, between depths of 41 and 50 fathoms. It was found to be very limited. The beam trawl and tangles were used successfully at stations 3078 and 3079, the former in 68 fathoms, muddy bottom, the latter in 55 fathoms, rocky bottom. Hand-line fishing was carried on at different times during the day, both from the ship and from small boats, with varying results, only a few fish being taken in some places, while at others, often close at hand, the catch would be large. The best success was met with in 52 fathoms, rocky bottom, where 24 specimens of the red and orange rockfish (*Sebastodes ruber* and *pinniger*) were obtained.

The only halibut taken by the *Albatross* on Heceta Bank was captured in the fall of 1888, and weighed 10½ pounds. Mr. Alexander states, however, that the schooner *George H. Chance*, of Portland, Oregon, anchored on the southern part of this bank in the evening of August 7, 1889, and in the course of a short time had captured several small individuals of this species. On a trawl line set over night the heads of 11 halibut were found the next morning, the bodies, apparently, having been destroyed by sharks and dogfish. The trip was finally abandoned owing to the annoyance caused by these pests. Further investigations are required to determine the value of Heceta Bank for halibut fishing, but the observations thus far made are not encouraging in that respect. The abundance of several other species, however, especially of the red rockfish, will furnish sufficient inducement to fishing vessels, whenever they can be assured of a ready market for their catch. The use of the beam trawl and of trawl lines on the rougher parts of the bank is impracticable, hand lines being most serviceable in such localities.

Inside of Heceta Bank.—After leaving Heceta Bank on September 1, 1889, the investigations with the beam trawl were extended to the muddy and sandy bottom lying between there and the mainland. Station No. 3080 was made a few miles to the eastward of the bank, in a depth of 93 fathoms, green mud, and disclosed a great wealth of fish life, the catch including about 100 flounders, representing several species, many rockfish, 1 black-cod, and 1 cultus-cod. Station No. 3081 was still nearer to the land, in about the same latitude, the depth being 61 fathoms, and the bottom consisting of green mud and sand. In this position 200 flounders were captured, besides an abundance of several other species. As the duration of these hauls did not exceed 20 minutes each, the value of this region as a beam-trawl fishing-ground must be conceded.

Umpqua River to Cape Blanco.—The observations were carried southward from the Umpqua River on September 12, 1889. Four miles south of the river, in a depth of 53 fathoms, 3 orange and 1 black rockfish were taken on the hand lines in the course of 15 minutes. A second trial, about 3 miles farther south, in a depth of 40 fathoms and lasting 25 minutes, afforded 22 orange rockfish. From this point, however, to the Coquille River, a distance of 28 miles, no fishes of any kind were captured, although stations were made in 8 different places. In 25 fathoms, rocky bottom, directly off the mouth of the Coquille River, 1 orange rockfish and 1 cultus-cod were secured; but from here to Cape Blanco all of the fishing trials again proved unsuccessful. Dredging station No. 3094 was in this region, about 11½ miles south of Coquille Point, depth 35 fathoms.

Orford Reef.—The fishery investigations on the coast of Oregon terminated at Orford Reef on September 12, 1889, although the hydrographic observations were continued to the California State line. Reaching the vicinity of the reef during the afternoon, Mr. Alexander was detailed to examine the shallow waters in one of the small boats, while the *Albatross* worked farther off shore. Only 2 dredging stations, Nos. 3095 and 3096, were made here, both with the tangles. They were located just to the south and southeastward of the reef, in depths of 33 and 42 fathoms, the bottom being very rich in animal life.

The exposed part of Orford Reef consists of several very rough ridges which rise abruptly from the sea. They are covered in places with sea lions, but, notwithstanding this fact the surrounding waters contain an abundance of food-fishes of several varieties. By far the best fishing was obtained on the south side of the reef, in 6 to 8 fathoms, hard and very irregular bottom. As it generally proved very difficult to release the anchor, it was found most expedient to lay to and drift with the wind and tide, although there was constant danger of losing the hooks and leads by their catching upon the rocks. A very large and interesting assortment of fishes was collected, including red and orange rockfish, vermilion rockfish (*Sebastodes miniatus*), cultus-cod, one black-cod, and several large sculpins. The cultus-cod were especially abundant. Equal success was obtained by the use of hand lines from the ship south and west of the reef.

CALIFORNIA.

NORTHERN BOUNDARY LINE TO POINT REYES.

Boundary line to Point Arena.—On October 12 to 14, 1889, the investigations which had previously been conducted on the coast of Oregon were continued down the coast of California as far as Cape Mendocino. Operations, however, were entirely restricted to sounding, with the object of defining the contour of the bottom on the continental platform from the shore line into depths of about 200 fathoms. In September, 1890, on the return trip from Alaska to San Francisco, the sounding work was resumed off Cape Mendocino and was carried thence southward as far as Point Arena. A line of five stations with the beam trawl (Nos. 3348–3352), begun off Point Arena, in a depth of 455 fathoms, was extended inshore just to the north of this point, but no trials either with hand lines or trawl lines were made within these limits.

The continental platform is relatively narrow along this entire stretch of coast. Off Point St. George, near Crescent City, it has a width, within the 200-fathom curve, of about 9 miles. Off Klamath River this width increases to 17 miles, but it becomes reduced again to 8 miles at Trinidad Head, and is very much less at Cape Mendocino. In the vicinity of Point Arena the platform attains a maximum width of 10 to 12 miles. There are no fishing-banks, properly so called, in any part of this region, but the usual coast fishes will undoubtedly be found in spots along the shore. The beam trawl may be used in the neighborhood of Point Arena, but there are some rocky places to be avoided. The captain of the steam fishing schooner *George H. Chance*, of Portland, Oregon, reports the capture of several halibut close to Cape Mendocino, in a depth of 40 fathoms. It is not probable, however, that this species can be taken there in paying quantities.

Point Arena to Point Reyes.—This region was examined between March 24 and 29, 1890, sounding work chiefly being carried on. As before mentioned, the 200-fathom curve is about 12 miles from shore at Point Arena, whence it follows the direction of the coast line as far as Salt Point. From this point, however, the platform broadens out, attaining a width of 20 miles off Russian River, of 26 miles off Tomales Point, and of 21 miles off Point Reyes. The bottom is smooth and is composed of alternating stretches of black sand and mud, the latter almost invariably occupying the slope between 100 and 200 fathoms. Stony patches also occur occasionally, usually between depths of 40 and 70 fathoms.

The beam trawl was used at only five stations north of Point Reyes. Stations 3171 and 3172 were off Russian River, in depths of 76 and 62 fathoms, respectively, the former on sandy and rocky, the latter on sandy bottom. The remaining positions were as follows: No. 3173, about 7 miles west of Bodega Head, 62 fathoms, mud; No. 3174, about 8 miles southwesterly from the same head, 65 fathoms, green mud; No. 3175, 11½ miles northwesterly from Point Reyes, 57 fathoms, brown mud. The bottom was found to be especially rich in the various species of flatfishes which belong to this coast, and several other edible kinds were also taken with them.

The Italian and Greek fishermen of San Francisco operate during the entire year as far north as Point Arena. They fish mainly with hand lines in depths of 10 to 30 fathoms, or within 2 to 3 miles of the shore, and as good fares are generally obtained in these positions they seldom venture into deeper water. The principal species taken are the red rockfish, which are especially abundant off Bodega Head, Tomales Point, and Point Reyes. Cultus-cod of extra large size are also found off the latter point.

Fishing is carried on in Tomales Bay and Bodega Bay throughout the year. From 30 to 40 fishermen restrict their operations exclusively to the former bay, using drag seines and trammel nets. Their catch is shipped to San Francisco by rail. The species secured here are red rockfish, perch, flounders, smelts, sea bass, herring, and anchovies. Hand lines and drag seines are employed in Bodega Bay, in which the catch consists chiefly of red rockfish, tomcod, and flounders.

POINT REYES TO POINT CONCEPTION.

Point Reyes to Monterey Bay.—Fishing and dredging operations were actively prosecuted by the *Albatross* on this part of the California coast between March 10 and April 13, 1890, affording very satisfactory results of a preliminary nature. As the contour and character of the bottom had been pretty thoroughly determined by previous surveys, the sounding work was mainly limited to special places in connection with the fishing and dredging trials, and to locating with greater care the positions of the 100 and 200 fathom curves along the outer border of the platform. Just north of the latitude of Point Reyes these curves bend abruptly outwards to include Cordell Bank and the Farallon Islands. The 200-fathom curve lies 21 miles off Point Reyes, and maintains about the same distance from the coast line until south of Pillar Point, passing within about 3 miles of Noonday Rock, 4 miles of the North Farallones, and 5 miles of the South Farallon. From about 25 miles off Pillar Point, however, the curve approaches to within 16 miles of Pigeon Point, bends abruptly inward at Point Año Nuevo, and at El Jarrow Point is only 8 miles from shore, retaining the same distance until off Santa Cruz in Monterey Bay.

This broad stretch of platform presents a generally uniform character of bottom. Between the Golden Gate, Pillar Point, the Farallones, and Point Reyes the bottom is sandy and free from rocks and stony patches, except in the immediate vicinity of the islands and of the shore line. Southward from Pillar Point rocky patches are frequently found near the shore, with fine gray sand farther off, finally merging into green mud at varying distances from land. Stony patches, apparently the result of drift, also occur between depths of 30 and 70 fathoms, on sandy or muddy bottom. The green mud has a strong odor which is occasionally offensive.

In view of the relatively short time spent in this region, it may be considered that the bottom was quite thoroughly tested with respect to its fishery resources, the beam trawl and hand lines being used for this purpose; but observations at other seasons would greatly increase the value of the results. Between the region off Point Reyes and the latitude of Pillar Point 26 dredging stations were made beside those on the defined banks which are elsewhere referred to. Twenty-four of these stations (Nos. 3099–3101, 3103, 3150–3157, 3163–3167, 3176–3182) were inside of the 100-fathom curve, while two (Nos. 3161 and 3162) were in depths of 191 and 552 fathoms. From the latitude of Pillar Point to the entrance to Monterey Bay 19 stations (Nos. 3106–3111, 3113–3122, 3147–3149) were occupied in depths less than 100 fathoms, and 9 stations (Nos. 3104, 3105, 3112, 3204–3209) in depths of 108 to 391 fathoms.

Some parts of the bottom were found to be much richer in life than others, and muddy depressions occur on which no food-fishes were obtained. As a result of the trials with the beam trawl it was observed that the shoaler water species were quite regularly distributed, flatfishes being the principal feature of every haul. Small specimens of the "deep-sea sole" were secured in depths of 50 fathoms and less. The "long-finned sole" was traced from near the shore into depths of 100 fathoms, the finest specimens occurring in the deeper water. These two species approach more nearly to the European sole than any others on the Pacific coast, the flesh of mature individuals being white, gelatinous, and exceedingly delicate in flavor. From experiments made on board the *Albatross* they were found, when kept on ice, to improve until the fourth day, but deteriorated after the seventh day. They can be captured only with the beam trawl or other form of drag net. Large specimens of the deep-sea sole seldom, if ever, reach the San Francisco market, as the fishermen restrict their operations to water too shallow for them. In consequence of this fact, no doubt, the fishermen have also had no incentive to increase the size of their fishing boats in this region, or to improve their character. While many of these boats, hailing from San Francisco as well as from Santa Cruz and Monterey, are stable and seaworthy, and often good sailers, they are lacking in accommodations and especially in comfortable quarters for the crew.

The variety of fishes taken during this investigation was quite large, but a discussion of them must be deferred until the completion of Prof. Gilbert's report upon the subject. Among them were a number of important food species, some of which occur in great abundance. The following list of the principal forms obtained has been prepared by Mr. Townsend. The remarks upon the relative abundance of the species are based entirely upon the observations of the *Albatross*.

List of the principal fishes obtained by the steamer Albatross between Point Reyes and Monterey Bay, March and April, 1890.

[Between the shore and the 50-fathom line.]

Scientific name.	Common name.	Relative abundance.
Citharichthys sordidus	Flounder	Abundant.
stigmæus	do	Rare.
Microstomus pacificus	"Deep-sea sole"	Few small ones.
Atheresthes stomias	Flounder	Rare.
Eopsetta jordani	do	Common.
Hippoglossoides exilis	do	Abundant.
Psettichthys melanostictus	do	Common.
Pleuronichthys decurrens	do	Do.
Parophrys vetulus	do	Abundant.
Glyptocephalus zachirus	"Long-finned sole"	Do.
Microgadus proximus	Tomcod	Few.
Porichthys porosissimus	Midshipman	Very abundant.
Sebastodes ruber	Red rockfish	Common.
pinniger	Orange rockfish	Do.
flavidus	Yellow-tail rockfish	Do.
miniatus	Vermilion rockfish	Do.
elongatus	Rockfish	Do.
auriculatus	do	Do.
goodei	do	Rare.
chlorostictus	do	Do.
(3 new species)	do	Very abundant.
(1 new species)	do	Rare.
Zaniolepis latipinnis		Common.
Ophiodon elongatus	Cultus-cod	Few.
Abeona	Perch	Common.
Genyonemus lineatus	Roncador	Do.
Atherinopsis	Smelt	Do.
Stolephorus	Anchovy	Do.
Chimæra colliei	Ratfish	Do.
Myxine glutinosa	Hag eel	Do.

List of the principal fishes obtained by the steamer Albatross between Point Reyes and Monterey Bay, March and April, 1890—Continued.

[In depths greater than 50 fathoms.]

Scientific name.	Common name.	Relative abundance.
Microstomus pacificus	"Deep-sea sole"	Abundant in 200 fathoms.
Atheresthes stomias	"Halibut" (flounder)	Rare.
Glyptocephalus zachirus	"Long-finned sole"	Common in 100 fathoms.
Sebastodes (3 new species)	Rockfish	Abundant.
Sebastolobus	Redfish	Do.
Anoplopoma fimbria	Black cod, Beshowe	Common.
Macrurus (3 species)	Grenadier	Few.
Lycodidæ (large species)		Rare.
	Eel pouts	Abundant.
Careproctus		Few.
Chauliodus	Viper-fish	Do.
Myctophum townsendi		Common.
Alepocephalus		Few.

The invertebrate fauna occupying this region is rich and diversified, the greatest variety of forms having been secured between depths of 100 and 600 fathoms. Inside of the 100-fathom curve the species differ essentially from those found on the coasts of Oregon and Washington. Shrimps and prawns, some of very large size, were obtained occasionally in depths of 50 fathoms and over. The common large edible crab (*Cancer magister*) was abundant, while *Cancer antennarius* and *Cancer productus*, both also edible, were common along the shores. The surface, however, was found to be practically barren of life, very little material being taken in the tow nets, but this may have been due to the season of the year.

The Farallon Islands.—The fishing-grounds adjacent to the Farallon Islands are among the most important on the coast of California. The fishing season lasts from September to May, and during this period work is actively carried on by means of trawls and hand lines. The principal anchorage is on the south side of the South Farallon, and the grounds surrounding this island are, as a rule, more productive than those about the North and Middle Farallones. The bottom is exceedingly rough and rocky, and very destructive to the fishing gear. Dredging station No. 3102, with the beam trawl, was off the Southeast Farallon, 27 fathoms, the bottom consisting of corals and broken shells. The principal edible fishes obtained by the *Albatross* around the Farallon Islands were flounders of several species, including two species of sole, and red rockfish.

Fanny Shoal is a small spot of fishing-ground, the center of which lies about 3½ miles northwesterly from the North Farallon. Large catches are sometimes made there. This locality was thoroughly examined by means of the dredge, tangles, and hand lines, stations 3158, 3159, and 3160 having been made in depths of 27 to 39 fathoms, rocky bottom. In the vicinity of Noonday Rock, flounders, soles, anchovies, tomcod, and other species were obtained in the beam trawl, but only red rockfish were taken on the hand lines.

Cordell Bank is located at the outer margin of the continental platform, about 21 miles northwesterly from the North Farallon, the shoaler part of the ground being between 19 and 20 miles due west from Point Reyes (latitude 38° N.). It was examined on March 24, 1890. The soundings showed numerous rocky patches extending over a somewhat larger area than is indicated on the published charts, but in a westerly direction the depths increase rapidly with a bottom of green mud. The area of the bank, so far as it has been determined, amounts to about 20 square miles, according to Capt. Tanner, the bottom consisting of rocks, sand, and shells, intermixed with mud. The least depth discovered is 25 fathoms. The tangles were used occasionally, and trials with hand lines were made from time to time, but the swell and strong current which prevailed rendered it difficult to keep the latter on the bottom. A cod trawl was set on the western part of the bank, and was allowed to remain down seven hours, the catch comprising 47 red rockfish and 2 cultus-cod. The former averaged 6½ pounds in weight, while the latter weighed 18 and 20 pounds, respectively. One orange rockfish, 2 yellow-tails, and 2 cultus-cod were taken with hand lines during a drift of about three-quarters of an hour. Subsequent trials, however, farther to the south, both with hand lines and with the trawl line, proved less successful.

Mr. Alexander considers that a small vessel with 6 to 8 dories might, under favorable conditions, obtain 4,000 or 5,000 pounds of fish a day, but a satisfactory estimate of the value of the bank can not be based upon the investigations thus far made. During the winter months a few large boats from San Francisco fish on Cordell Bank for red rockfish and cultus-cod, but the Italian and Greek fishermen who engage in this business take little pains to extend their knowledge of the ground beyond the few spots with which they have accidentally become acquainted.

Drake Bay furnishes the first important inshore fishing-ground south of Point Reyes. Drag seines only are employed here by the fishermen, who make use of large boats, which generally go in companies of three to five, each taking its turn in carrying the catch to market. The *Albatross* visited this locality twice during March and April, 1890, but met with no success, either in the bay or about Point Reyes. The bottom was thoroughly tested with hand lines, and trials were also made with crab nets. A cod trawl was set for six hours across a rocky patch of ground on the northern side of the bay, but only 2 small flounders were secured. In summer rockfish are said to frequent this ridge, but never in great numbers.

At a beam-trawl station off the entrance to Drake Bay the catch consisted of 100 flounders, representing several species, half a dozen anchovies, a few herring, and several red rockfish and tomcod.

Ballenas Bay, situated not far northward from the Golden Gate, is a favorite locality for fishing with trammel nets. The principal species obtained there are red rockfish, sea bass, and cultus-cod.

Two beam-trawl stations, Nos. 3181 and 3182, were made off the entrance to this bay. The former was located 4 miles SW. by W. from Duxbury Point, in 16 fathoms, the catch comprising 20 flounders of three species, 50 anchovies, 3 tomcod, 1 smelt, 6 perch, and a large quantity of other forms. The latter was 1 mile WNW. from the northern edge of Four Fathom Bank, in 11 fathoms, flounders, anchovies, soles, and shrimps being obtained. The sole inhabiting these shallow waters are smaller than those taken farther offshore.

Coast line south of the Golden Gate.—Directly south of the Golden Gate, between Point Lobos and Point San Pedro, a distance of about 11 miles, the waters close inshore are said to be comparatively barren of food-fishes. From May to September trawl and hand-line fishing is carried on between Point San Pedro and Point Año Nuevo, red rockfish being the species chiefly sought for. The San Francisco fishermen do not venture beyond the latter point, but others, beginning there, follow this calling farther to the southward.

Monterey Bay and vicinity.—Monterey Bay has an extreme length, north and south, of about 22 miles, and is open to the ocean for nearly this entire distance. The greater part of the bay has depths less than 100 fathoms, but directly off the mouth of Salinas River begins a deep trough or valley, which extends westward, with irregular margins at the 100-fathom line, and widens somewhat rapidly until it opens into the deeper parts of the adjacent ocean. A maximum depth of something over 400 fathoms is found within the limits of the bay.

Two visits were paid to Monterey Bay by the steamer *Albatross*, the first between March 12 and 15, the second on April 10 and 11, 1890, and much sounding and dredging work was accomplished. A continuous series of dredging stations, outside of the limits of the bay, was run in a curved line from off Sand Hill Bluff, in the north (latitude 36° 57′ N., longitude 122° 10′ W.), to off Point Pinos, in the south, as follows: No. 3123, 37 fathoms; No. 3125, 65 fathoms; No. 3146, 62 fathoms; No. 3126, 456 fathoms; No. 3127, 418 fathoms; No. 3128, 627 fathoms, and No. 3129, 204 fathoms. Stations 3124 and 3136 to 3144, inclusive, were in the northern part of the bay, on a small bank off Santa Cruz and in the region adjacent to it; stations 3130 to 3135, inclusive, and 3145 were in different parts of the bay, in depths of 9 to 56 fathoms; and 3202 and 3203 in the submarine valley off the Salinas River, in depths of 382 and 138 fathoms, respectively.

This bay is regarded as one of the most productive fishing-grounds on the coast of California, but during the winter of 1889–90, when these investigations were made, fishes of all kinds were unusually scarce, owing, it is supposed, to the phenomenal rainfall which had taken place. Within 24 hours after a heavy rain the surface becomes covered with muddy water, which is said to have the effect of driving the fishes from the shallow grounds, and continued stormy weather has a tendency to keep them from such places.

The small bank off Santa Cruz, above referred to, is a rocky ground, the center of which lies about 2 miles SSW. from the light-house. It has an area of about 14 square miles, the depths ranging from 8 to 20 fathoms. The Coast Survey chart gave no indication of the rocky bottom, and the attention of the *Albatross* was attracted to it by the number of boats engaged in fishing there. The bank is resorted to both summer and winter. During the latter season the Monterey fishermen work mainly on grounds in the southern part of the bay near the entrance. Drag seines and gill nets are also employed on the smooth bottoms and sandy beaches throughout the region.

Fishing operations were diligently prosecuted by the *Albatross* during both visits, the trials being made chiefly with the beam trawl, seines, and hand lines. The tabular list of fishes given previously belongs also in part to this region, especially the outer or more exposed portion. Along the beaches perch and smelts were secured in large quantities by means of the drag seine. A small striped bass (*Roccus lineatus*) was also taken in the same manner, this being the most southern locality from which it has so far been recorded. It is not native to California, but has been introduced from the Atlantic coast. Gill nets and a trawl line were set about 1½ miles from the harbor anchorage at Monterey, one barracuda being captured in the former but nothing in the latter. The winter fishing-grounds are some 5 or 6 miles farther offshore, but during fine weather red rockfish are frequently caught close to the head of the bay.

Monterey Bay to Point Conception.—The examination of this region was begun on April 3, 1890, off Cypress Point, just south of Monterey Bay, and was carried thence southward, the beam trawl being frequently used in connection with the sounding operations. A depth of 245 fathoms was found within a mile and a half of Cypress Point, below which place the 200-fathom curve gradually leaves the coast until west of Point Sur, where it is distant between 9 and 10 miles from shore. Five miles southwest from this point, however, a depth of 293 fathoms was indicated by the lead, with 36 fathoms a little more than a mile inside. Thence to Lopez Rock the shore is exceedingly bold, the 200-fathom curve approaching within 2 miles or less. Subsequently it diverges slightly until off Piedras Blancas, where it is between 6 and 7 miles from the point. The coast from Carmel Point to Piedras Blancas is entirely open and exposed to the full force of the ocean swell, which causes a tremendous surf, even with the ordinary coast winds. Slight protection may be found under Point Sur, but even that can not be depended on in bad weather.

Southward from Piedras Blancas the character of the coast line changes materially, and there are various points where fairly good anchorage may be found, San Simeon Bay affording the best protection north of San Luis Obispo. As the shore line becomes less abrupt, shoal water extends farther seaward, 200 fathoms being found 7 miles off San Simeon Point, about 10 miles off Point Esteros and Point Buchon, and between 13 and 14 miles off Point San Luis. Then sweeping a little seaward, off Points Sal and Purisima, it approaches within about 8 miles of the bold headland of Point Arguello and 10 miles from Point Conception.

Stations 3183 to 3197, with the beam trawl, were made between Monterey Bay and Point Conception, in depths of 41 to 328 fathoms, the bottom consisting chiefly of sand and mud, with rocks in some places. Poor success attended the trials with the beam trawl and hand lines off Cypress Point. The fishermen do not resort to this locality in the winter, but fish are said to be abundant there during the summer months. Very large "deep-sea sole" (*Microstomus pacificus*) were taken in considerable numbers in deep water off the entrance to Monterey Bay, while the same and other species of flatfish, together with black-cod, red rockfish, whiting, etc., were obtained at most of the beam-trawl stations southward from the bay. Large quantities were never captured at a time, but these forms were found to range over an extensive area. Windy weather, unfortunately, prevented successful work with the hand lines.

A cod trawl was set off the northern entrance to San Simeon Bay, on a sharp, rocky patch of ground, and seining was carried on along the beaches, but neither mode of fishing gave satisfactory results. San Simeon Bay has been for many years one of the principal whaling stations on the Pacific coast, and very little attention is paid to other kinds of fishing. During the winter of 1889-90 ten boxes of smelts, weighing 160 pounds each, were caught in gill nets by one man. This is the largest catch recorded for a single season in this locality.

Seven whales were captured during 1888 and the same number during 1889. The former yielded 180 barrels of oil, the latter 260 barrels, this difference being chiefly due to a difference in their size. December, January, and February are the principal months during which whales frequent this locality, but sometimes a few are seen as late as the middle of March. During these months they are making the "down run," and they are then said to contain about 50 per cent more oil than during the return or "up run," which is, as a rule, of shorter duration, lasting only from four to six weeks. Twenty-one men and nine boats are employed at this station during the whaling season.

POINT CONCEPTION TO THE MEXICAN BOUNDARY LINE.

This region was examined during January and February, 1889, but a few observations were also made at other times—in the course of the voyage from Norfolk to San Francisco, in 1888, and during the cruise southward from the latter place in March and April, 1890. Along this portion of the coast the continental platform, as defined by the 100-fathom curve, is everywhere narrow and yet quite irregular in its width, being sometimes less than a mile wide, and attaining a maximum breadth of about 13 miles off Santa Barbara. Notwithstanding this fact, however, the several islands surrounded by shallow water which occur off the land, and the two small but important banks farther south, combine with the surface of the platform to offer exceptional advantages for fishing, which can never be fully utilized until larger markets shall have been established within convenient distances.[1] The most important hydrographic work accomplished by the *Albatross* was in connection with the deeper soundings between the outer islands and the mainland, and with those made on Cortes and Tanner banks and in the adjacent waters. Dredging and fishing operations were carried on extensively and with good success.

Santa Barbara Channel begins directly to the south of Point Conception and has a general east and west trend, being included between the mainland, on the one hand, and the islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa, on the other, the distance of these islands from the coast varying from 10½ to 25 miles. The channel is largely occupied by water over 100 fathoms deep, the maximum depth recorded being 366 fathoms.

Santa Catalina Island is situated about 18 miles off Point Fermin, from which it is separated by San Pedro Channel, having a greatest depth of 422 fathoms. The Gulf of Santa Catalina lies southeasterly of the island of the same name and between San Clemente Island and the mainland, the least distance between the two being about 50 miles. The intervening depths exceed 600 fathoms in some places. Santa Barbara Island is about 22 miles west of Santa Catalina Island, and San Nicolas Island about 24 miles farther in a southwesterly direction, the latter being distant about 54 miles from Point Mugu, the nearest point upon the coast. Cortes and Tanner banks are about 95 miles due westerly from San Diego.

The total area adjacent to the coast of California south of Point Conception investigated by the *Albatross* may be estimated at about 11,000 square geographical miles.

Capt. Andrea Larco, the principal fisherman of Santa Barbara, with eighteen years' experience along this section of the coast, accompanied the *Albatross* on several of the trips, and his thorough acquaintance with the region greatly increased the value of the fishing trials.

Santa Barbara Channel.—This channel, as already stated, has a varying width of about 10½ to 25 miles, being narrowest at the eastern end, between Anacapa and the mainland. On the northern side, between Point Conception and Goleta Point, the 100-fathom curve is generally from 3 to 4 miles from shore, but off Santa Barbara it bends abruptly outward to a distance of about 13 miles, so as to form an extensive area at the eastern end of the channel with depths less than 100 fathoms. On the southern side the same curve approaches within about 5 miles of the nearest point of San Miguel Island (Harris Point), somewhat closer to the corresponding projection on Santa Rosa, and within 3 miles and less of Santa Cruz and Anacapa. South of this group the distances are somewhat less, the 100-fathom curve lying from 2½ to 4½ miles off San Miguel, and about 2 miles off Santa Rosa and Santa Cruz, with some exceptions to be explained below.

In the western half of Santa Barbara Channel the area of deep water (exceeding 100 fathoms) has, therefore, a relatively great width, occupying in the main about two-thirds of the entire breadth of the channel; but at the eastern end it becomes reduced in places to less than one-fourth the breadth. The bottom consists chiefly of mud, and this same material extends more or less into shoaler water. The greatest depth recorded is 366 fathoms, about midway of the channel.

Several dredgings with the beam trawl have served to indicate the principal features of this deeper area. Station 2840 was made during the voyage to San Francisco in the spring of 1888, and was north of San Miguel Passage, in a depth of 276 fathoms, the bottom consisting of green mud. The season of 1889 was begun at station 2891, about 12 miles west of Point Conception, where 1 black-cod, 7 red rockfish, and an abundance of deep-sea soles, together with two specimens of octopus, were obtained in 233 fathoms, mud bottom. Stations 2892 and 2893 were directly in the western entrance of the channel, in depths of 284 and 145 fathoms, respectively, yellow mud and fine gray sand and mud. Five other stations in the deeper water were subsequently occupied during the same season, as follows: No. 2903 (322 fathoms), No. 2904 (314 fathoms), and No. 2909 (205 fathoms), north of Santa Rosa Island; No. 2910, off Goleta Point, 229 fathoms; No. 2960, north of San Miguel Passage, 267 fathoms. Comparatively little life was discovered on the bottom at any of these positions, but at station 2960 several black-cod were secured.

In April, 1890, four stations (3198–3201) were made through the center of the channel from off Point Conception to off Goleta Point, in depths of 233 to 280 fathoms, green mud.

No surface organisms were taken in this region. Regarding this subject Capt. Tanner states:

> The total absence of life on the surface was notable, and it would seem that the season alone is not sufficient to account for it. The presence of petroleum, which may usually be seen forming a thin film over the surface waters of the channel, may have something to do with it.

Mr. Alexander describes the oil as sometimes occurring in small patches, and at others covering large areas, in the region off Santa Barbara light, at a few miles from shore. Its prevalence, he thinks, "probably prevents migratory fishes from schooling in this part of the channel, and possibly may tend to influence their movements over a considerable distance both up and down the channel." It is not unlikely that the barrenness of much of the bottom may also be due to this cause.

Vicinity of Point Conception.—On January 8, 1889, a trawl line was set in 20 fathoms of water, rocky bottom, about 7 miles east of Point Conception, hand lines also being used from the ship and from a small boat at the same time, but no fishes of any kind were taken. Four stations (2905–2908) with the beam trawl and tangles were then made in a short line running off from this position, the depths ranging from 31 to 96 fathoms, and the bottom being exceedingly variable in character. A considerable number of invertebrates was secured, but nothing indicating a good fishing-ground.

Off Santa Barbara.—The examination of the fishing-grounds off this place, conducted on February 11, 1889, was described by Capt. Tanner as follows:

> We left our anchorage at 7 a. m. on the 11th, and, piloted by Capt. Larco, examined a fishing-bank, the center of which lies E. ½ N. (magnetic) about 3 miles from Santa Barbara light-house. It is about a mile in length NE. and SW., by half a mile in width, soundings regular, with depths from 12 to 20 fathoms, fine black sand, with frequent stony patches or spots, on which there is a live bottom.
>
> Another bank was examined and found to be between 2 and 3 miles in length, E. by S. and W. by N. (magnetic), and almost 1 mile in width, its center being 5 miles ESE. from the light-house. The soundings were regular with depths from 26 to 29 fathoms, which agreed closely with the Coast Survey chart, as did those on the bank previously examined. The bottom was sandy, with frequent stony patches, as before described.
>
> The stones were composed of hardened clay, filled with holes, easily crumbled in the hand, and strongly resembling the tosca of South American coasts. It was covered with kelp, sponges, bryozoans, and other marine growths. The lead did not give the true character of the bottom, and it was ascertained by dragging the trawl or tangles between stations, stony patches, some of them very small, being encountered every two or three ship's lengths. Kelp was found growing on all of them, much of it being brought up by the trawl, the roots still adhering to their stony ballast. It seemed to be a young growth, as none of it reached the surface. According to Capt. Larco, these banks were at one time alive with fish, but being so near the harbor they were soon fished out, and are visited now only by rowboats or sailing craft too small to go to the islands. There are no indications of these rocky or stony patches on the Coast Survey charts.
>
> Later in the day, a small rocky patch, marked on the chart 4 miles south (magnetic) from the light-house, was partially examined, and muddy bottom, with rocks and coral patches, was found in from 50 to 60 fathoms. It was not known to the fishermen of Santa Barbara, but Capt. Larco was confident that it was a spot on which, many years ago, an old Indian used to fill his canoe when others failed to catch anything on the known banks.

Eleven stations (2961–2971) with the beam trawl and tangles were made in the vicinity of the first-mentioned grounds, in depths of 20 to 31 fathoms, and three stations (2972–2974) outside of the last and the deeper ground, in depths of 61 to 73 fathoms, green mud.

Viviparous perch were the principal fishes obtained by seining on the beach at Santa Barbara during a visit made early in April, 1890.

Vicinity of San Miguel Island.—Investigations were conducted in the neighborhood of Richardson Rock, and between there and San Miguel Island, on January 5, and again on February 8, 1889. Stations No. 2894 and 2895, with the dredge and tangles, were made on the former date, in a depth of 53 fathoms, sand and broken shells, about a mile and a half to the westward of the rock, but the bottom, so far as could be determined, was very barren. In nearly the same position a trawl line was set for about an hour and hand lines were also employed. Four red rockfish were caught upon the former, but nothing with the latter, and the baits generally remained untouched.

On February 9 a line of fishing stations was occupied between Richardson Rock and the northern side of San Miguel Island, by way of Wilson Rock, and a party was sent out under the direction of Capt. Larco to investigate localities inaccessible to the ship. The fishing trials are thus described by Mr. Alexander:

> The first fishing was done in 44 fathoms, Richardson Rock bearing WSW. ½ W. (magnetic), distant 1½ miles. Ten red rock-cod and 10 yellow-tails were caught in a few minutes' time. The next berth was in 41 fathoms, Wilson Rock bearing E. by S. (magnetic) 2.3 miles distant, only one small

flounder being taken during a 10-minute trial. The last trial made between Richardson and Wilson rocks was in 36 fathoms, the latter rock bearing ESE. (magnetic), distant 1.6 miles; 4 red rock-cod and 3 rock bass were captured.

From the above station the ship ran E. ¼ S. 1.2 miles and hove to in 42 fathoms, Wilson Rock bearing S. by E. ½ E. and close to. Fifteen lines were soon over the ship's side and fishing began. Mr. Larco and the writer went out in the dingey to try for fish around the rock. Seven or eight trials were made in depths varying from 25 to 35 fathoms, but we did not meet with as good success as was expected by Mr. Larco. He had frequently anchored over the same ground where we were fishing and had loaded his boat in a few hours, but this was late in the season. Many trials were also made to the southward of the rock, where large numbers of whitefish generally feed in summer, and still our efforts were only poorly rewarded. The total catch was 4 red rock-cod, 3 whitefish, 1 cultus-cod, 1 sculpin, 1 rock bass, 1 scorpion, and 1 black rock-cod. On returning to the ship we found the deck covered with fish. It had drifted but a few minutes when they were encountered in great abundance, every line hooking at once and those who participated had keen enjoyment for 2 hours. Fishing began in 34 fathoms and was continued into 23 fathoms. The total number of fish taken was 555, viz: 481 yellow-tail rockfish (*Sebastodes flavidus*), 49 red rock-cod, 1 cultus-cod, and other species.

Yellow-tail fishing very much resembles pollock fishing on the New England coast. The former species will invariably follow the lines to the surface, and frequently bites at the hook just before reaching the ship's side. Another peculiarity in which these fish resemble the pollock is that as soon as they begin to bite they swim up in the water, and more can be caught on short lines than on the bottom. After a few have been taken they will rise to within a few fathoms of the surface and dart in schools at the lines. They then immediately disappear, soon to repeat the same performance.

On the afternoon of the same day, while on the way to Santa Barbara, three dredging stations were made to the northward of the eastern end of San Miguel Island. The first two (Nos. 2957, 2958) were only a short distance from the shore, in the vicinity of Prince Island, the depth being 26 fathoms and the bottom consisting of gray sand and rocks. The dredge and beam trawl were used and a rich bottom was discovered. Station No. 2959 was about 4½ miles north of this end of the island, in a depth of 55 fathoms, sand, mud, and broken shells. Several black-cod were taken in the beam trawl.

The beam trawl and tangles were employed on January 6, 1889, to the west and southwest of the island, at distances of about 1 to 6½ miles from shore. Station 2899 was nearest the island, off Wyckoff Ledge, in a depth of 44 fathoms, gray sand and broken shells, but the net caught on some projecting rocks and was wrecked. At station 2897, Point Bennett, on San Miguel Island, bearing NE. by N. ½ N., 3¼ miles, 197 fathoms, rocky bottom, the tangles were used and a trawl line was set for about an hour, securing 4 black-cod, 1 red rockfish, and 2 ratfish (*Chimæra*). This and other similar localities along this portion of the coast may possibly offer good advantages for a fishery for the black-cod, but further trials are necessary to determine that fact. Station 2898 was near 2897, in a depth of 158 fathoms, while No. 2896 was in 376 fathoms, yellow mud. A rich fauna was found at both of these places.

On February 8 a beam-trawl station (No. 2956) was occupied off the southern entrance to San Miguel Passage, about 3½ miles from the eastern end of the island of the same name, depth 52 fathoms, the bottom consisting of fine gray sand and rocks. Later, on the same day, the *Albatross* anchored off the southern side of the island, and a fishing party was rowed close inshore among the rocks and kelp, where, in a short time, 28 specimens of red rockfish, whitefish, and rock bass were taken. Fishing trials from the ship proved ineffectual. During the summer the salt-water crayfish (*Panulirus*) is abundant about the shores of San Miguel Island, and large numbers are obtained there both for bait and for the market.

Vicinity of Santa Rosa Island.—In the evening of January 6, 1889, a trawl line was set in the outer part of Becher Bay, at the eastern end of this island, the depth being 20 fathoms. It was allowed to remain down over night, but in the morning only 1 puffer shark (*Cephaloscyllium ventricosum*), 3 sea-anemones, and 1 crab were found on the hooks. Shore collections were also made at this place, but the surf was too heavy to permit of seining. The small dredge was then hauled in the bay at station No. 2900, 13 fathoms, sandy bottom, and subsequently two beam-trawl stations (Nos. 2901, 2902) were made about 4 miles north of Beacon Reef, in depths of 48 and 53 fathoms, many interesting specimens being obtained.

On the morning of February 8, a line of dredging and fishing stations was run through Santa Cruz channel, and thence several miles southward along the crest of a ridge which extends in the direction of San Nicolas Island, but the full extent of this shallow water was not determined. Subsequently the work was continued off the southern side ot Santa Rosa Island as far as San Miguel Island. The bottom consisted of clean hard sand, with frequent sharp rock projections.

The following dredging stations were made during the day, namely: No. 2950, in Becher Bay, 21 fathoms; No. 2949, 155 fathoms, and No. 2951, 48 fathoms, at the southern entrance to Santa Cruz Channel; No. 2952, 57 fathoms, No. 2953, 82 fathoms, No. 2954, 65 fathoms, and No. 2955, 121 fathoms, on the ridge extending south from Santa Rosa Island. The following account of the fishing trials is from Mr. Alexander's report:

> At station 2953, latitude 33° 47′ N., longitude 110° 58′ 15″ W., depth 82 fathoms, the dingey was lowered for the purpose of testing the bottom with hand lines. A short distance from the above station the bottom suddenly dropped off into 100 fathoms and a fair trial failed to give us any results. We shifted our berth several times in the direction of the shore, gradually shoaling the water to 60 fathoms, in which depth we obtained 2 red rock-cod. The position where we left the ship was about 10 miles from Santa Rosa Island. In changing berths we probably worked a mile in towards shore. Adding this to the distance steamed by the ship in going over this ground and we have a rocky ledge about 5 miles long and with a depth of 65 to 90 fathoms developed during the morning, on which red rock-cod, whitefish, and fat-heads will probably be abundant at certain seasons. The extent of the ledge, however, may be much greater. The results of dredging indicate a rich bottom.

Off the south side of Santa Cruz Island.—The beam trawl was used on February 7, 1889, in two positions not far apart off the southern side of Santa Cruz Island. The results obtained have been described as follows by Capt. Tanner:

> Two of the hauls of the afternoon, Nos. 2947 and 2948, in 269 and 266 fathoms, were among the richest of the cruise, a great variety of specimens, including 4 black-cod, being obtained. The latter were rather under the medium size, but their flesh was excellent in flavor, nearly, if not quite, equal to those taken off the Oregon and Washington coasts. The deep-water sole is another excellent fish found here, and ranks among the best sea fishes on the Pacific coast, far superior to any that reach the Santa Barbara or San Diego markets.

The "deep-water sole" referred to is the *Glyptocephalus zachirus*, a relative of the pole flounder of the North Atlantic Ocean. It could be taken only in the beam trawl or some similar bottom drag net. The black-cod, however, is an active fish, which could best be captured by hook and line, and the fact that 4 specimens were secured in the beam trawl may possibly indicate its presence here in considerable numbers.

Anacapa Passage and Island.—Investigations were made in this region on February 6 and 12, 1889. On the former date dredging stations No. 2943, 2944, and 2945 were made directly in the passage, in depths of 30 to 31 fathoms, rocky and pebbly bottoms; while station No. 2946 was to the southward of Smuggler Cove, Santa Cruz Island, in a depth of 150 fathoms, coarse gray sand. It was found that the eastern or Anacapa side of the passage has a live bottom, and is a favorite fishing-ground, while on the opposite side the bottom consists of clean sand with little or no life.

The following account of the fishing operations is by Mr. Alexander:

> We commenced fishing in 30 fathoms, the SE. end of Anacapa Island bearing E. by N. ¼ N., San Pedro Point NW. ¾ W. After remaining there about fifteen minutes we shifted to the south and west into 27 fathoms, the above-mentioned points bearing E. by N. ¾ N. and NW. ¼ W., respectively. In these two drifts of short duration, 20 red rockfish and fat-heads were captured.
>
> Two other trials were subsequently made on the following bearings: In 28 fathoms, San Pedro Point NW. by W. ½ W.; south and eastern end of Anacapa Island, E. by N. In 27 fathoms, the former point bearing NW., the latter ENE. The result of these trials was as follows: 22 whitefish (*Caulolatilus princeps*), 4 fat-heads (*Trochocopus pulcher*), 26 red rockfish, 8 black rockfish (*Sebastodes mystinus*). A short distance to the eastward of Anacapa Passage the bottom is sandy and comparatively barren.
>
> Early in the evening an anchorage was made by the ship in Smuggler Cove, where a large-mesh gill net was set for two hours among the rocks and kelp close by the shore. This was done about dark, a little too late to expect a large catch, such species as are generally taken in a gill net usually meshing just before dark or before sunrise. Only one crayfish was secured. The next morning the net was set in the same place, and at the time several sea lions were observed upon the rocks. The net was hauled after breakfast and contained 90 fish, of which the greater number were viviparous perch. The sea lions had been there before us, however, as was made manifest by the number of large holes in the net caused by their efforts to steal the fish. Sea lions are still found scattered about the Santa Barbara Islands, where they greatly annoy the fishermen, not only by devouring the fish taken but also by injuring and often entirely destroying their nets.
>
> The remainder of the morning was spent in seining along the sandy beach of Smuggler Cove, an excellent locality for that purpose, as there are no sharp rocks or other obstacles in the way. Notwithstanding its advantages, however, only a few perch, sharks, etc., were collected.

On February 12 the following dredgings were made entirely with the beam trawl: No. 2975, 36 fathoms, in Anacapa Passage; No. 2976, 31 fathoms; No. 2977, 45 fathoms, and No. 2978, 46 fathoms, directly off the south side of Anacapa Island; No. 2979, 388 fathoms, about 4 miles south of Anacapa Island, and No. 2980, 603 fathoms, about 11 miles south of Anacapa Island. At the last two stations the bottom consisted of green mud; at the preceding ones of sand, gravel, pebbles, and broken shells. Mr. Alexander describes the results of fishing trials as follows:

> On the morning of February 12 many hauls were made with the beam trawl in Anacapa Passage and off the southern end of Anacapa Island. A haul 11 miles south of the island in 603 fathoms (station 2980) was one of the richest made in this region. Two trials were also made for bottom fish on the southern side of Anacapa. The first was in 52 fathoms, 1¼ miles south of Arch rock; the second was in 36 fathoms, 1 mile north of the same rock. Six red rockfish were captured. A strong breeze was blowing at the time, which caused the ship to drift rapidly, and consequently a large catch could not be expected, but a sufficient number were secured to demonstrate the presence of fish in this position, and they might have been taken in abundance under more favorable circumstances.

List of the principal food-fishes obtained in the vicinity of the Santa Barbara Islands.

[Prepared by Charles H. Townsend.]

Serranus clathratus, Rock bass.
  nebulifer, Bass.
Sphyræna argentea, Barracuda.
Abeona minima, Perch, Shiner.
Micrometrus aggregatus, Shiner, Sparada.
  rosaceus.
Amphistichus argenteus, Surf-fish.
Trochocopus pulcher, Fat-head.
Caulolatilus princeps, Whitefish.
Anoplopoma fimbria, Black-cod, Beshowe. Only obtained in the deeper water and taken only in the beam trawl.
Sebastodes vexillaris, Rockfish.
  chlorostictus, Rockfish, Vermilion fish.
Sebastodes miniatus, Vermilion rockfish.
  elongatus, Rockfish.
  proriger, Rockfish.
  entomelas, Rockfish.
  flavidus, Yellow-tail rockfish.
  crassus, Rockfish.
  notospilotus, Rockfish.
Sebastolobus, Rockfish. Taken only in deep water.
Parophrys vetulus, Flounder.
Citharichthys sordidus, Flounder.
Hippoglossoides exilis, Flounder.
Microstomus pacificus, "Deep-sea sole."
Glyptocephalus zachirus, "Long-finned sole."
Pleuronichthys verticalis, Flounder.

Notes on the fisheries of the Santa Barbara region.—The following notes on the fisheries of this region are extracted from the report of Mr. Alexander made in 1889:

Mackerel strike in at the Santa Barbara Islands and Channel about the 1st of March and remain until October. Mr. Larco has never seen any fat mackerel on the coast and doubts if they ever become fat. They sometimes school in small "pods" during the summer months in Santa Barbara Channel, but he has never seen them school in the vicinity of San Pedro or farther south. They are caught by trolling and in gill nets, but chiefly by the former method.

The herring accompany the mackerel, but remain much longer in this region. Strong westerly winds drive them offshore, where they remain until the wind changes. They are taken in gill nets and drag seines.

Sardines (*Clupea sagax*) are found here the year round in considerable numbers, and are captured in gill nets and drag seines, chiefly for bait. They are affected by westerly winds in the same manner as the herring.

Fat-heads, yellow-tails, red rockfish, black rockfish, and whitefish are similar in their habits to the shore cod and pollock of the Atlantic coast.

Rock-lobsters or crayfish, sardines, and herring make the best bait, although whitefish and perch are very good. Squid are sometimes caught in great numbers in nets and drag seines, but it is said that the fish will not bite at them.

Sea bass, of which no specimens were taken by the *Albatross*, are said by Mr. Larco to be first seen some time in March. After remaining upon the coast about two months they suddenly leave, reappearing in July and August. They have been known to strike the coast three times during a season, but as a rule they appear only twice. The customary method of fishing for them is with gill nets. The net is 40 fathoms long and 3 fathoms deep, with a 6-inch mesh. A southeast wind causes them to seek deeper water and very few are taken at such times.

Sharks and dogfish give the fishermen much trouble in the summer, when they are very abundant, playing sad havoc with the nets and all other kinds of fishing appliances. There are many excellent places on the Santa Barbara Islands where try works could be built at slight expense in localities where these fishes might be captured in large numbers within half a mile of the shore.

During January, February, and March only hand-line fishing is resorted to. Through the four succeeding months no attempt is made to catch any fish but barracuda and mackerel. During the last months of summer but little attention is given to fishing of any kind, there being little demand for this kind of food. The poor demand for fish at that season arises from the fact that the fishermen have not the means of preserving and marketing their catch in suitable condition. The price of ice is so high that its use would increase the cost of fish beyond the means of the majority of the people. Most of the fish are now sold at from 10 to 15 cents per pound in the Santa Barbara market, but 18 cents is sometimes paid for fat-heads, whitefish, red rockfish, and yellow-tails.

> Nearly every spot about the Santa Barbara Islands where rocky bottom is found may be considered a fishing-ground. Red rockfish and fat-heads are found from close to the rocks out into depths of 90 fathoms, but they are most abundant where the water is from 15 to 25 fathoms deep. Some places are much more favorably regarded than others. Anacapa Passage is one of the best grounds, and can generally be relied on throughout the entire year. In the vicinity of Richardson Rock is another good ground, and Wilson Rock is considered the most prolific spot about the islands during the first three months of the year. Between these rocks and the northern end of San Miguel Island red rockfish, fat-heads, and whitefish occur in considerable numbers in the summer, but during winter these species are more abundant about the rocky patches off the shores of Santa Rosa, Santa Cruz, and Anacapa. The best ground for yellow-tails is in close proximity to Wilson Rock.
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> The best season for fishing is during the winter months, when the winds are variable and gentle. In summer the northwest trades sweep down the coast, often with great velocity. At such times the fishermen resort to the northern end of the group, thereby receiving the benefit of a fair wind to Santa Barbara when a full load has been secured.
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> Rainy weather affects the movements of both surface and bottom fish. Mr. Larco states that he seldom finds anything in his nets during a rainy spell, and long experience has taught him to resort to some other method of fishing during such times.
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> The salt-water crayfish (*Panulirus interruptus*) is caught in trammel nets and in small net traps. The latter are very much like the traps used by the boat fishermen along the shores of Long Island Sound and Massachusetts Bay for catching cunners. They are somewhat smaller, however, and have two iron hoops instead of one, to which the net is fastened. One is at the top and measures about 2 feet in diameter, while the second, at the bottom, is only 10 inches across. They are placed 2½ feet apart, that being the length of the trap. A wire cage about the size of a saucer is attached at the bottom and serves to hold the bait. The bridle, to which the line for lowering and hauling the trap is fastened, consists of four lines tied to the upper hoop. These lines are rove through a small piece of wood which acts as a float to prevent their settling down over the cage and covering the bait. When resting on the bottom the top hoop falls in such a manner as to fully disclose the bait.
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> Mr. Larco's boats are all carvel-built and with keels; they are open and have a wash rail, small deck forward, and lateen rig. They are about 25 feet long, 7 feet wide, have a straight stem and sharp stern, with the rudder hung outside. The accommodations for sleeping and cooking, as in all other boats of this class, are very poor. The fish are thrown into the bottom of the boat as soon as caught, and covered with seaweed to protect them from the sun.

San Pedro region.—After completing a line of soundings and dredgings between San Diego and Point Fermin, February 4, 1889, search was made for a reported shoal off the latter place, but, apparently, it does not exist. Subsequently an examination was made of South Bank, which is described as follows by Capt. Tanner:

> It extends about 10 miles SE. by E. (magnetic) from San Pedro light-house, and is from 3 to 3½ miles in width. The depths increased regularly to 20 fathoms 2 miles from the point, and to 29 fathoms at the outer extremity. The soundings correspond generally with those of the Coast Survey chart, and the bottom was usually the same dark-gray sand; but putting the trawl over, it frequently dragged over stony patches, on which kelp, sponges, bryozoans, etc., were growing.

Beam-trawl stations Nos. 2938 to 2942, inclusive, were on and about this bank at distances of 6 to 11 miles from Point Fermin, in depths of 20 to 47 fathoms. Mr. Alexander has reported as follows concerning South Bank and the fisheries generally of this region:

> This bank is 3½ miles wide and covers an area of about 30 square miles; the good fishing-spots are confined to a much smaller area, however, being generally in depths of 20 to 28 fathoms. About twenty-five small fishing boats are engaged in fishing on this bank the year round. Flounders, red rockfish (called groupers locally), herring, bonito, mackerel, and smelt are caught in their proper seasons. Red rockfish are taken during the entire year and are in greatest demand. Herring, mackerel, and smelt are caught in gill nets and drag seines, and frequent chiefly the shoaler water close to the shore. Mackerel are often trolled for, as in the San Diego region. Los Angeles is the principal market for all fish taken on this bank, a uniform price of 5 cents per pound being paid for all the species, except mackerel. The price of the latter fluctuates, according to the supply and demand; 200 pounds of fish is considered a fair day's work with hand lines.

The fishing for red rockfish is carried on in a manner not unlike that for grouper in the Gulf of Mexico. When the ground is reached, the boat is luffed up into the wind and a sounding made with a baited hook attached to the lead. If no fish are found on two trials, the boat is again given headway, and a new berth taken a short distance from the first one. This operation is repeated until a place is found where the fish are abundant, when the jib is hauled down, the main boom guyed out, and the boat allowed to drift a short distance. If the fish continue to bite, the anchor is lowered. The fish feed upon small spots and ridges covered with kelp, and, as they can not be tolled away from their feeding-ground, an anchorage has to be made as nearly as possible over these localities; otherwise very poor results may be expected. Fishing is actively continued until the place is exhausted, when a new berth must be sounded out. Frequently one or two boats will have excellent fishing while a dozen or more may meet with no success. These fish appear to move about from place to place, and the good fishing-grounds of one day may be entirely deserted the next.

Most of the boats belonging to San Pedro that fish on South Bank and vicinity are sloop-rigged and keeled. They average 20 feet long and 6½ to 7 feet wide. Their accommodations are as good as could be expected on boats of their size, and are far better than on similar boats farther south. Herring and salt-water crayfish or rock-lobster (*Panulirus*) are used for bait.

The fishermen of San Pedro and adjacent places are mostly Scandinavians, Portuguese, and Italians, the Scandinavians being in the majority. Many of the Italians fish about San Clemente and Santa Catalina Islands, while those of other nationalities pay little attention to those islands, resorting chiefly to South Bank. The Italians have a few fish-houses and a flake-yard on Santa Catalina, where they dry fish in summer. No attempt is made to split and dry fish in the winter, and during that season the fishermen remain mostly on the inshore grounds.. A favorite spot for summer fishing lies 1½ miles from the eastern end of Santa Catalina Island. Large quantities of red rockfish are taken there, and also whitefish (*Caulolatilus princeps*) and fat-heads (*Trochocopus pulcher*) at certain seasons.

Hand lines only are used for bottom fishing in this region. Trawl lines would be of little service on the rocky patches, as the fishing areas are of small extent and much of the trawl would be spread out over barren ground. The gear is rigged in the same manner as that of the hand-line fishermen of San Diego.

The San Pedro fishermen state that bonito strike this part of the coast the first of March and mackerel a month later. The method of catching them here, as previously explained, is by means of troll lines and gill nets. The fishermen also affirm that they have never seen mackerel schooling in the vicinity of South Bank, although herring and sea bass frequently school in large bodies. This is, however, the region from which most of the schools of mackerel have been reported by passing vessels. These reports are not unnatural, in view of the fact that even an experienced eye is often deceived in attempting to distinguish between schools of mackerel and herring, and it is sometimes impossible to determine the species until specimens have actually been taken in the nets.

Alamitos Bay and Newport Harbor.—These two inlets were examined by Prof. C. H. Gilbert on January 12 and 13, 1889, with reference to their adaptability for oyster-raising, the density and temperature of the water being carefully determined.*

Santa Catalina Island.—This island was visited by the *Albatross* on February 14, 1889, but unfavorable weather prevented an investigation of the fishing-grounds. The fisheries in its vicinity, however, have been referred to in the last extract given above, from the report of Mr. Alexander.

Santa Barbara Island.—The only dredge haul made in this vicinity was at station No. 2982, about 5½ miles southwesterly from Santa Barbara Island, depth 178 fathoms, the bottom consisting of sand, gravel, and mud. Mr. Alexander describes the fishing trials close by the island as follows:

An anchorage was made in the afternoon on the northern and eastern side of Santa Barbara Island, where the naturalists were landed. A crab net, baited with fresh whitefish, was put over the side, but nothing was captured in it. The hand lines did better, although during the first hour no bites were felt Towards evening, however, a school of red rockfish and whitefish passed under the ship, and between 40 and 50 of them were caught. The longer we fished the more plentiful they seemed to become. The dingey, with Capt. Tanner and the writer, was rowed to a point about half a mile to the westward of a reef of sharp rocks which makes off from the shore, where we fished for about an hour, making several changes in our position during that time. The catch consisted of three red rockfish and one fat-head. One large flounder (*Paralichthys californicus*), of the kind called halibut by the fishermen of San Diego, was hauled to the surface of the water, but, owing to its being "lip-hooked," it managed to free itself, greatly to our disappointment.

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*Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. F. C., IX, 1889, pp. 95-98, 3 maps, 1 plate.

San Nicolas Island.—This island was visited on January 18 and February 13, 1889, but stormy weather prevented extensive observations on both occasions. On the former date seining only was carried on, two hauls being made at the eastern end of the island. Abalone shells occur here in great abundance, and are collected for the market. A Chinese boat, in search of these mollusks, reached the island at about the same time as the *Albatross*. A small amount of fishing with hand lines was done during the morning of February 13. Two trials were made before good grounds were discovered. The third position was 2 miles WSW. from the island, in a depth of 21 fathoms, 17 red rockfish, 3 whitefish, 2 yellow-tails, 1 fat-head, 1 cultus-cod, and 4 jacks (*Sebastodes paucispinis*) being captured in the course of ten minutes. The boat then drifted into deeper water, where no fish could be obtained, but on returning to a depth of 22½ fathoms good fishing was again secured, the same species being taken, but in smaller quantities.

Lines of deep-sea soundings have been run, connecting San Nicolas Island with Tanner Bank at the south and San Clemente Island at the east, and defining the contour of the bottom for some distance to the north of San Nicolas Island.

Cortes and Tanner Banks.—These two banks, which are located about 95 miles due west of the coast end of the boundary line between the United States and Mexico, constitute the most important offshore fishing-grounds on the coast of California south of San Francisco. They are only a few miles apart, but are separated by depths of 100 to something over 200 fathoms. Coast and Geodetic Survey chart No. 5000 represents them on a very small scale, with their outlines defined by the 100-fathom curve. A more detailed chart is given in the report of Capt. Tanner, contained in the Annual Report of the Fish Commission for 1888–89. They are here outlined by the 50-fathom curve as inclosing that portion of each bank which has been most thoroughly surveyed and fished over, especially in the case of Cortes Bank, the larger of the two. Capt. Tanner's account of the examination of Cortes Bank is as follows:

> Arriving at the bank the following morning (January 16), we commenced investigations by sounding, dredging, and the use of hand lines. The sea was breaking heavily over Bishop Rock, which made an excellent landmark, enabling us to locate ourselves on any part of the bank with certainty and without loss of time. The examination was completed on the evening of the 17th, and the general results may be stated as follows: The charts are on scales entirely too small to admit of details being shown. Bishop Rock, on which there is but 10 or 12 feet, is the shoalest part of the bank The sea breaks over it heavily during moderate weather; but with a smooth sea, when facing the sun, it can not be seen at any distance and is at such times very dangerous. The depths correspond generally with those on the charts, with the exception of a 6-fathom spot which was found about a mile south and east of Bishop Rock. This might have led to a less depth, but there was a heavy swell at the time, which induced us to seek deeper water. Our soundings extended the area of the bank in a southwest direction, where it requires further examination. The bottom was composed of sand, shells, coral, and rock, the latter cropping out at short intervals over the entire surface. The fauna was very rich and varied. Fish were swarming over the bank in great numbers, and, in fact, it was found to be the richest ground we have found in the Pacific. The trawl line was set and quite a number of fish taken, but the bottom was too rough for that method of fishing. Dan-

gerous seas will be encountered on the bank in stormy weather, and heavy swells with moderate winds, but it is of small extent, and with the deep water surrounding it is not an unusually dangerous fishing-ground.

Starting from the northern end of the bank a little after dark on the evening of the 17th, we ran a line of soundings in the direction of San Nicolas Island for 12 miles, in depths less than 300 fathoms, 38 fathoms being found at 18 miles (Tanner Bank). This we marked for future investigation and continued our course to the island.

Tanner Bank, so named by the Superintendent of the U. S. Coast and Geodetic Survey, was not examined until the 24th of January. The following brief description is by Capt. Tanner:

Its greatest length inside of the 50-fathom curve is 8 miles east and west (magnetic) by 2 miles in width at its eastern extremity, narrowing to 1½ miles at the western end. The center of the bank, on which was found 48 fathoms, is in latitude 32° 43′ N., longitude 119° 10′ W., and the least water, 28 fathoms, was found near the eastern end, in latitude 32° 42′ 30″ N., longitude 119° 07′ 15″ W. The bottom is composed of sand and shells, with numerous rocky patches, on which the fauna was found to be identical with that of Cortes Bank in similar depths. The 50-fathom curve on the east end lies north (true) 16 miles from Bishop's Rock, both being on the same submarine plateau, with intervening depths of less than 300 fathoms. The same species of fish found on Cortes were taken on this bank, and it may be considered a valuable addition to the fishing-grounds of the Pacific coast.

The fishing trials on Cortes Bank are thus described by Mr. Alexander:

January 16 we sounded in 60 fathoms on Cortes Bank (dredging station No. 2911, latitude 32° 27′ 30″ N., longitude 119° 05′ W.) where hand lines were put over, taking 2 red rockfish and 1 whitefish (*Caulolatilus princeps*) in the course of about fifteen minutes. A second trial was made soon after at hydrographic station 1621, latitude 32° 25′ 30″ N., longitude 119° 05′ W., depth 17 fathoms, bottom rocky. Fishing was carried on with hand lines for forty-five minutes, during which time the vessel drifted into 5 fathoms of water. The results were as follows: 17 fat-heads (*Trochocopus pulcher*), 10 yellow-tails (*Sebastodes flavidus*), and 2 sea bass (*Serranus clathratus*). The strong and sharp teeth of the fat-heads played sad havoc with hooks and gangings, stripping the former from the snoods nearly as fast as they could be put on. These fish would be very destructive to trawl lines set across the rocky patches which they frequent. The yellow-tail rockfish would follow to the surface any struggling captive at the end of a line, their movements somewhat resembling those of the Atlantic coast pollock.

Having baited a trawl while the hand-line fishing was going on, we set it at 12:40 p. m., in 26 fathoms, hard bottom. It was allowed to remain down one hour, after which no little difficulty was experienced in hauling it, because many of the hooks caught on the bottom and it was necessary to break the hooks or part the gangings to recover it. When within about 10 fathoms of the end the ground line broke, and we were obliged to haul the remainder of the trawl from the other buoy. The result of the trial was 18 fish, as follows: 2 red rockfish, 3 whitefish, 1 treefish (*Sebastodes serriceps*), and 12 fat-heads. We arrived on board the steamer at 3:55 p. m. While the trawl was down, dredging and hand-line fishing were carried on from the ship, the following species being taken by the latter means: 39 fat-heads, 37 yellow-tails, 1 whitefish, 3 red rockfish, 2 black rockfish (*Sebastodes mystinus*), 1 scorpion (*Scorpæna guttata*), and 2 jewfish (*Stereolepis gigas*). The two specimens of the last-named species weighed 155 and 190 pounds respectively. The fat-heads averaged 10 pounds each in weight. Fishing began in 25 fathoms and was carried into 8½ fathoms.

January 17, sounding, dredging, and fishing were carried on continuously over Cortes Bank. Seven trials with the hand lines, from a quarter to half an hour each in duration, were made during the day, resulting in the capture of 95 fish. The first was at hydrographic station 1631, 47 fathoms, where 1 whitefish and 1 yellow-tail were caught. The second was at hydrographic station 1632, 26 fathoms, where 15 whitefish, 5 red rockfish, and 2 fat-heads were taken. One cultus-cod, 1 yellow-tail, 2 red rockfish, and 1 whitefish were the total results of about twenty minutes' fishing at hydrographic station 1633, depth 43 fathoms. The fish took the bait less eagerly than on the preceding trials, and we observed that the vessel had drifted from places where we were hauling them "pair and pair" into others where not a single bite would be felt. The bank seemed to have many spots or ridges where all the species mentioned occurred in great abundance, but on leaving these places good fishing stopped. The fishing greatly resembled that for red snappers in the Gulf of Mexico.

At hydrographic station 1636, 45 fathoms, no fish were taken. We were possibly drifting in a little gully, and a slight change of position to either side might have brought us over good ground. Twenty-two whitefish, 11 red rockfish, and 3 fat-heads were subsequently secured in twenty minutes at hydrographic station 1639, 30 fathoms; and 11 fat-heads, 4 yellow-tails, 1 black rockfish, and 1 scorpion (*Scorpæna guttata*) in a few minutes, at hydrographic station 1640, 11 fathoms. The last trial of the day was made shortly after dark at hydrographic station 1641, 51 fathoms, for the purpose of determining the effects of darkness upon the fishing. The results seemed to prove that the fish will not bite after dark, as we were in a good locality and could feel the fish constantly striking against our leads and lines, but not a single specimen was taken on the hooks.

Cortes Bank was found to be the most promising offshore fishing-ground on the California coast south of San Francisco. It has an area of 51 square miles, with depths less than 50 fathoms. The deeper parts of the bank have been surveyed to a slight extent only, but it is probable that good fishing will also be found outside of the 50-fathom limit. The shoal part of the bank is about 15 miles long (WNW. and ESE.), its center being in about latitude 32° 26′ 30″ N., longitude 119° 08′ W. Bishop's Rock, which reaches to within 2½ fathoms of the surface, lies in latitude 32° 25′ 40″ N., longitude 119° 06′ 30″ W. A fishing vessel at anchor on the bank to windward of this rock would probably find it extremely uncomfortable if caught out in a heavy gale; but as the rock is small, a staunch schooner could work out by it into deep water, if not anchored too near it when the storm began.

Previous to the investigations of the *Albatross* nothing was known respecting the food-fishes inhabiting this bank. The demand for fish along this part of the coast is so limited at present that the fishermen do not find it necessary to venture outside of a few headlands in search of new grounds. They can give but little authentic information respecting the fishing-grounds 25 to 30 miles off the coast. The fishing areas adjacent to San Diego and Santa Barbara are sufficient for the immediate requirements of those places, but with a considerable increase in population, more distant and deeper grounds will have to be sought for, necessitating the building of a larger and better class of fishing boats. Small vessels patterned after the eastern well or smack boats could make quick and safe passages to and from Cortes Bank. A week or a fortnight could be spent, if necessary, in obtaining a fare, and by the end of that time fish would still be in good preservation, whereas the present methods compel the fishermen to market their fish daily to prevent their becoming unfit for sale.

Twelve stations were made on and about Cortes Bank with the dredges, tangles, and beam trawl. They are as follows: No. 2911, 60 fathoms; No. 2912, 10 fathoms; No. 2913, 26 fathoms; No. 2914, 26 fathoms; No. 2915, 55 fathoms; No. 2916, 93 fathoms; No. 2917, 99 fathoms; No. 2918, 67 fathoms; No. 2919, 984 fathoms (about 12½ miles southwest of Bishop Rock); No. 2920, 87 fathoms; No. 2921, 145 fathoms; No. 2922, 47 fathoms.

Deep-sea soundings were run from Tanner Bank to San Nicolas Island and to the southern end of San Clemente Island. A third line connects Cortes Bank with the region off Point Loma. The latter developed a series of elevations and depressions over which the depths varied from 211 to 1,047 fathoms.

The following are the principal food-fishes obtained on Cortes Bank by the use of hand lines:

Serranus clathratus, Rock bass.
Stereolepis gigas, Jewfish.
Trochocopus pulcher, Fat-head.
Caulolatilus princeps, Whitefish.
Ophiodon elongatus, Cultus-cod.
Sebastodes paucispinis, Jack.
    flavidus, Yellow-tail rockfish.
    melanops, Black rockfish.
    mystinus, Black rockfish.
Sebastodes miniatus, Vermilion rockfish
    constellatus, Rockfish.
    rosaceus, Corsair.
    chlorostictus, Rockfish.
    vexillaris, Rockfish.
    serriceps, Treefish.
Scorpæna guttata, Sculpin.
Citharichthys sordidus, Flatfish.

Vicinity of San Clemente Island.—While passing up the coast on the voyage to San Francisco, in May, 1888, a short stop was made in Smuggler Cove at the southeastern end of San Clemente Island, but only shore collecting was attempted. Subsequently the beam trawl was hauled successfully in a depth of 414 fathoms, gray sand bottom, about 7 miles off the northern end of the same island (station 2839).

The region was again visited on January 23 and 25, 1889. In the evening on the former date, a gill net was set in Smuggler Cove, and was allowed to remain down over night, but, although a school of fish, supposed to be herring, was seen at the surface, nothing at all was captured. The exceeding phosphorescence of the water, which imparted a glow to the entire net, may have been accountable for their failure to mesh. On the 25th a party was landed at the southeastern end of the island, where they found an excellent beach for seining, although the surf was running somewhat heavily at the time. Repeated hauls were made with the net, securing a good representation of the shore fishes, among which were large numbers of viviparous perch (*Amphisticus argenteus*) and a few smelts.

Several fishermen belonging to a San Diego sloop were encamped on the island. They made use of hand lines, fishing in depths of 30 to 40 fathoms, and obtaining fatheads, rockfish, whitefish, etc., which were split and salted. Short trawl lines were also employed at times, and traps were set for capturing salt-water crayfish. The sloop visited the island once every week or ten days and carried the catch to San Diego.

Gulf of Santa Catalina and the region off San Diego.—Two lines of deep-water soundings, including a few dredging-stations, were run through the Gulf of Santa Catalina from off Point Loma, one in the direction of Point Fermin, the other extending through the passageway between Santa Catalina and San Clemente Island. A third line extends from off Point Loma to Cortes Bank, as explained above. In addition to these a number of dredging and fishing trials were made directly off San Diego and about Los Coronados.

The dredging stations were distributed as follows : No. 2937, 359 fathoms, near the center of the Gulf of Santa Catalina; No. 2923, 822 fathoms; No. 2924, 455 fathoms; No. 2925, 339 fathoms; No. 2926, 69 fathoms; No. 2929, 623 fathoms; No. 2934, 36 fathoms; No. 2935, 124 fathoms, and No. 2936, 359 fathoms, off San Diego, within a maximum distance of 15½ miles from land; No. 2930, 60 fathoms; No. 2931, 34 fathoms; No. 2932, 20 fathoms, and No. 2933, 36 fathoms, in close proximity to Los Coronados; No. 2927, 313 fathoms, and No. 2928, 417 fathoms, between San Diego and San Clemente Island.

Los Coronados are located just south of the boundary line between California and Lower California. Important fishing-grounds exist in their immediate vicinity, and, lying very near to San Diego, they are much resorted to. The following account of investigations made in this locality on January 26, 1889, is from the report of Mr. Alexander:

> On the morning of January 26 investigations were begun in the vicinity of Los Coronados Islands. The first trial for fish was made with hand lines at hydrographic station 1706, latitude 32° 25′ N., longitude 117° 18′ W., 51 fathoms, 5 red rockfish and 1 fat-head being taken. The next fishing was done at dredging station 2931, 34 fathoms, latitude 32° 25′ 30″ N., longitude 117° 16′ 45″ W., and was a failure. These stations were between the North and South Coronados. A small Italian fishing boat was anchored close by where the last trial was made. She was on a favorite spot, but had met with poor success, the catch for the previous twenty-four hours having amounted to only about 50 pounds of red rockfish, whitefish, and fat-heads. During the summer months these species are sometimes very abundant.

Such fish as are taken in the vicinity of Los Coronados and San Diego bring from 3 to 4½ cents per pound. Very few are salted by the Italian fishermen, the salt-fish trade being monopolized by the Chinese. The Italians fish with both hand lines and line trawls, but chiefly with the former on account of their cheapness. Trammel nets are frequently used among the rocks close inshore, and fish that will not readily take the hook are often caught with them. A trammel net 30 fathoms long and 2½ fathoms or 40 meshes deep costs $25. A trawl of 500 hooks, completely rigged, and including the basket in which it is coiled, is valued at $5. Baskets are used on this coast for the storage of the trawls in preference to the tubs of the Atlantic coast. The trawl hooks used by these fishermen are the same as those employed by the French fishermen on the Grand Bank and by the fishermen on the coast of Spain. * * * The best fishing about the islands is found between the Northern and Southern Coronados in 25 fathoms. Close to the southern side of the northern island the water is deeper, having an average depth of 45 fathoms. In this latter place red rockfish are the principal species taken. About 5 miles south of the southern island is a small shoal ground sometimes resorted to by San Diego fishermen. These two "spots" are the only offshore fishing-grounds known in the immediate vicinity of San Diego.

The Italian fishing boat previously referred to was a primitive affair about 18 feet long, 7 feet wide, and 2 feet deep, with a flat bottom. * * * The hand lines employed were as rudely constructed as some of those made by the Alaskan Indians. Many sizes of lines were noticed with pieces of lead attached. Each line is generally provided with from 3 to 5 hooks, fastened to short snoods arranged one above the other about 18 inches apart. This style of gear is found about Kadiak, Alaska. Demijohns of various sizes, tied to the buoy lines by their handles, serve in place of keg buoys. The reason for using the former, as well as many other inconvenient devices, is their greater cheapness.

Mr. Alexander also furnishes the following notes respecting the mackerel, barracuda, and bonito in this region:

While in San Diego several fishermen were consulted who were more or less acquainted with the habits of the species of mackerel belonging to that part of the coast. According to their statements these fish strike the coast in the vicinity of San Diego in April and May on their way north. They are invariably poor at that season, and, in fact, during most if not all of the year, although some claim to have seen a few fat mackerel in October. Their migratory habits are similar to those of the Atlantic mackerel. The fishermen assert that they have seldom seen them schooling at the surface, notwithstanding the many reports of steamers and other vessels respecting large schools of mackerel along the coast. It is probable that many of the schools of fish so reported are not mackerel, but herring, the appearance of these two species, when at a distance, being readily confounded by those who are not familiar with them.

It is very doubtful if mackerel approach this coast in sufficient numbers to warrant the fitting out of vessels for their capture, after the manner followed on the New England coast. Many persons have thought that it would be a paying investment to do so, in order to compete with the New England fishermen for the Pacific coast markets, supplying both the salt and fresh fish. Any such venture would be precarious, however, until the habits and abundance of the species have been positively determined, and certainly not more than two vessels should be fitted out in the beginning. All the evidence goes to prove, moreover, that the Pacific mackerel (*Scomber colias*) is greatly inferior in quality to its Atlantic relative (*Scomber scombrus*), and those eaten on the *Albatross* were pronounced insipid.

The fishermen of San Diego, Santa Barbara, and San Pedro resort almost wholly to trolling for the capture of mackerel. The practice of heaving to and raising them with troll bait seems to be unknown in this region. A few are caught in gill nets, but large quantities are never taken at a time by either method. The greater part of the catch is sold in San Francisco.

During the summer barracuda are abundant about San Diego and along the coast toward Santa Barbara, but after September they become scarce, although scattering individuals are taken the year round. Ten or 12 schooners and sloops, of from 10 to 28 tons each, belonging to San Diego, follow down the coast of Lower California a distance of about 170 miles in search of both barracuda and bonito. The latter species is also sometimes called Spanish mackerel. They are caught by trolling, and, after being split down the back like mackerel, are salted in bulk in the hold of the vessel, the same as codfish. The catch is chiefly landed in San Diego, where the fish are dried on flakes and then shipped to the Sandwich Islands and China by way of San Francisco.

INVESTIGATIONS SOUTH OF CALIFORNIA.

During the several trips made by the *Albatross* southward from California very important fishery, biological, and hydrographic information has been obtained, but it is not intended to make more than a brief reference to these investigations in this connection. On the voyage from Norfolk, Va., to San Francisco, in the winter of 1887–88, observations were continued during the entire cruise, and after leaving the coasts of South America stops were made at the Galapagos Islands, Panama, Acapulco, La Paz, and several places along the outer shores of Lower California. During the early spring of 1889 a visit was paid to the Gulf of California, and from January to April, 1891, the ship was engaged upon a special scientific investigation, under the direction of Prof. Alexander Agassiz, off the coast of Mexico, Central America, and Ecuador, including the region about the Galapagos Islands.

OUTER COAST OF LOWER CALIFORNIA.

After completing the investigations on the coast of California, in February, 1889, the *Albatross* proceeded southward en route for the Gulf of California, but in order to examine certain reported dangers to navigation off Lower California the cruise was not made direct. A line of soundings was carried first to Guadeloupe Island, and thence to the Alijos Rocks, in latitude 24° 58′ N., longitude 115° 52′ 36″ W., and to the Revillagigedo group, of which Clarion, Socorro, and San Benedicto islands were visited in the order named. Important collections of fishes and other marine animals were obtained at each of these places and also by dredging in the intervening deeper waters. Interesting observations upon the physical and natural-history features of the different islands were likewise made and have been published in the annual report for 1888–89, pp. 432–436, 466–468. The hydrographic results have been summarized as follows by Capt. Tanner:

> Reports of islands, rocks, and reefs in the regions recently traversed by the *Albatross* have been current from time immemorial. The U. S. S. *Narragansett's* investigations resulted in their being expunged from the charts, but she gave us no information regarding the contour of the ocean bed, which is the only sure method of deciding the existence or non-existence of submarine elevations. This gap has been filled by the soundings of the *Albatross*, which prove definitely that these vigias do not exist in the positions assigned them.
>
> Another important problem has been solved. The chain of islands commencing with Guadeloupe and extending to Los Alijos and the Revillagigedo group have been considered as a submerged mountain range, extending parallel with the peninsula, connected with it by a submarine ridge at one extremity, and previous to the submergence inclosing a gulf similar to the Gulf of California. The *Albatross* soundings not only show this to be an error, but demonstrate the fact that the several islands are isolated volcanic elevations, entirely independent of the continent and of each other, the sea reaching its normal depth between each of them and also between them and the peninsula.

The observations directly along the outer coast of Lower California, both in 1888 and 1889, were carried northward from Cape St. Lucas, and they will be referred to in the same geographical order.

Only one dredge haul (No. 2829) has been made in the vicinity of Cape St. Lucas, the tangles having been used in a depth of 31 fathoms, rocky bottom, off the Frailes. Station No. 2830 was in 66 fathoms, fine sand, latitude 23° 33′ N.

Visits were paid to Magdalena Bay in both years, and considerable collecting was done in that vicinity by means of the dredging appliances, nets, etc. Food-fishes were found to be abundant, many specimens of mullet, perch, anchovies, smelts, and flounders being captured in the seines and beam trawl. Several schools of mackerel were observed off the entrance to the bay on April 9, 1889; they were working northward. Excellent oysters had been reported from this locality, and a search was made for them, but without success. Mangrove oysters, however, were discovered about 40 miles farther north, near Boca del Soledad.

On May 4, 1888, several dredge hauls were made in the shallow waters about Abreojos Point, and on April 11, 1889, numerous fishing trials were conducted in San Bartolome Bay (latitude 27° 40′ N.) by means of seines and hand lines. This bay has been reported to be an excellent fishing-ground, but nothing was captured on the hand lines, which were used in several places among the submerged rocks and ledges off the mouth of the harbor, although mullet, smelts, anchovies, and flounders were plentiful along the beaches. The U. S. S. *Ranger* arrived at the bay at about the same time as the *Albatross*, and, making use of a very large seine, secured 167 green turtles, besides two or three dozen fishes, of several species, in a single haul. Some of the turtles were of very large size.

Cerros Island was visited on May 5, 1888, and again on April 12 of the next year, several dredging stations being occupied about the island, while the shore fishes were collected by seining. Subsequently, in 1889, seine hauls were made in San Quentin Bay and on the shores of San Martin Island.

GULF OF CALIFORNIA.

On the voyage north in April, 1888, a stop was made at La Paz, Lower California, for the purpose of coaling, and advantage was taken of the opportunity to dredge at several stations in La Paz Bay, in San Lorenzo Channel, and between Cerrabro Island and the mainland, off Point Gorda.

In 1889 the investigations were carried to the extreme head of the gulf, the main object of the cruise having been to ascertain the principal characteristics of this sheet of water in their relations to the Colorado River, in which plantings of shad had previously been made by the Fish Commission. The course of the ship was from La Paz to San Josef Island, Carmen Island, Conception Bay, Guaymas, San Pedro Nolasco Island, Angel de la Guardia Island, Georges Island and Bay, Consag Rock, and the mouth of the Colorado River. Thence it returned to Guaymas and La Paz, making several stops on the way. Sounding and dredging operations, together with fishing trials and observations of temperature and density, were continued throughout the cruise, much valuable and interesting information being obtained. An account of the work accomplished is contained in the Annual Report for 1888–89, pp. 436–443, 468–471. The shallow waters at the mouth of the Colorado River were found to be very barren of life, and the conditions generally seemed unfavorable to the successful stocking of that river with shad or other anadromous fishes. The gulf itself, however, has many important fishery resources, some of which have been developed to a limited extent, while others must await the demands of future markets.

While in the neighborhood of Guaymas an examination was made of the extensive oyster beds occurring in Algodones Lagoon, the introduction of this southern species on the coast of California having been suggested. This oyster is of excellent quality and closely resembles the Atlantic coast species of the United States. It was formerly marketed in San Francisco, and is still transported to other places not so far distant from the grounds. Beds of oysters are quite widely distributed through the gulf, but comparatively little is known about them except in this vicinity. The beds of Algodones Lagoon have been discussed by Prof. Charles H. Gilbert and Mr. Charles H. Townsend. (F. C. 14, 15.)

THE SOUTHERN CRUISE OF 1891.

This important expedition, under the scientific direction of Prof. Alexander Agassiz, occupied the three months from February to May, 1891, the area covered by the investigations lying off the western coast of Mexico and of Central and South America, between Cape San Francisco in the south and Guaymas in the north, and extending seaward to include the region about the Galapagos Islands. The biological and physical features of this region, as well as the contour and character of the bottom, except in the vicinity of the coast, were then almost entirely unknown, the *Albatross* having made only a few observations there during the voyage from Washington to San Francisco, while H. M. S. *Challenger*, during her famous expedition around the world, sailed directly from the Sandwich Islands to Chile and thence into the Atlantic Ocean. The inquiry, as planned, had reference mainly to the natural history and temperature of the deeper waters off the coast, at the bottom and surface, and also at intermediate depths.

Beginning off Cape Mala near Panama, a line of stations was carried to Cocos Island, and then, with some deviation toward the south, to Malpelo Island, and back to Panama, while several short lines were run immediately outside of the 100-fathom curve. On the second cruise the steamer proceeded first to the vicinity of Cape San Francisco, thence to the Galapagos Islands, and from there to Acapulco. Subsequently dredgings were made from off Cape Corrientes to Guaymas, in the Gulf of California. The greatest depth of water explored was 2,232 fathoms. Short stops were also made at the different islands lying in the course of the expedition for the purpose of studying the land and shallow-water animals and plants. While it was observed that the marine fauna of this region is not so rich as that occupying the corresponding waters off the east side of the continent, very large collections were secured, and the general results obtained are of great importance.

One of the most important outcomes of the expedition has been the determination by Prof. Agassiz, through the instrumentality of a new form of intermediate towing net devised by Capt. Tanner, of the vertical distribution of the surface pelagic fauna, which he considers to descend only to a depth of about 200 fathoms. Some forms among the bottom animals may work up a distance of several fathoms, but between these levels in the open sea he found no evidences of life. Regarding this subject there are still some differences of opinion among explorers, and further investigations will be awaited with much interest. As a solution of the problem will probably have some bearing upon the study of the habits of pelagic fishes, the practical importance of continuing the experiments can readily be appreciated.

Detailed accounts of this expedition have been given by Commander Tanner and Prof. Agassiz (F. C. 9, 17 and 18).

MAPS, CHARTS, AND OTHER PUBLICATIONS BEARING UPON THE FISHERY INVESTIGATIONS OF THE STEAMER ALBATROSS.

The Fish Commission publications are enumerated below. [illegible] the reports [illegible] of the oceanographic and other investigations of the Albatross, and a few papers from the "Fisheries and Fishery Industries of the United States," which contain a complete review of all that was known respecting the marine fisheries and fishing-grounds of the Pacific coast down to 1880. The charts of the U. S. Coast and Geodetic Survey and Hydrographic Office of the Navy are those on which the soundings of the Albatross have been plotted, and they can otherwise illustrate the regions over which her work has been extended. The most useful charts for the Alaskan coast, in connection with this report, are Fish Commission Nos. 19, 20, 21, 22, Coast Survey [illegible] and [illegible], together with the several native charts, and Hydrographic Office chart [illegible]. The general coast charts of the Coast Survey on a scale of 1:200,000 constitute a uniform series covering the entire coast line of Washington, Oregon, and California, and contain a sufficient amount of detail to answer for most fishing purposes. For the coast of southern California the Hydrographic Office charts and Fish Commission [illegible] should be consulted.

PUBLICATIONS OF THE U. S. FISH COMMISSION.

[illegible]

1. The fishery resources and fishing-grounds of Alaska. By Tarleton H. Bean. The Fisheries and Fishery Industries of the United States. By George Brown Goode and a staff of associates. U. S. Fish Commission. Section II, pp. [illegible], 1887.
2. The cod fishery of Alaska. By Tarleton H. Bean. Idem. Section V, vol. I, pp. [illegible], 1887.
3. [Resources of the economic fishes of the Pacific coast of the United States.] By David Starr Jordan. Idem. Section I, [illegible]. The discussion of the different economic species will be found under the special natural groups to which they respectively belong.
4. The sea fishing-grounds of the Pacific coast of the United States from the Straits of Fuca to Lower California. By David S. Jordan. Idem. Section III, 1887, pp. [illegible].
5. The fisheries of the Pacific coast. By David Starr Jordan. Idem. Section II, 1887, pp. [illegible].
6. Report on the work of the U. S. Fish Commission steamer Albatross from January 1, 1887, to June 30, 1888. Lieutenant-Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm. [illegible], for 1888, pp. [illegible]. [Includes the narrative of the cruise from Washington to San Francisco, [illegible].]
7. Report upon the investigations of the U. S. Fish Commission steamer Albatross for the year ending June 30, 1889. Lieutenant-Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm. [illegible], for 1889, pp. [illegible]. [Contains narrative of investigations off the south side of the Alaska peninsula, summer of 1888; off the coasts of Washington, Oregon, southern California, and Lower California, and in the Gulf of California, 1888 and 1889. Includes also report of A. B. Alexander, fishery expert, and chart of Cortes and Tanner banks.]
8. Explorations of the fishing grounds of Alaska, Washington Territory, and Oregon, during 1888, by the U. S. Fish Commission steamer Albatross, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. U. S. Fish Comm., VIII, for 1888, pp. 1-95. [In this report the investigations of 1888 are discussed in geographical sequence beginning at the north. It contains two large charts, one covering the fishing grounds off the south side of the Alaska Peninsula, the other showing the operations on the coasts of Washington and Oregon as far south as Tillamook Rock and on Heceta Bank. The latter chart is now incomplete, much additional work having been done in that region during subsequent years. Recent Coast Survey charts, enumerated below, give full data in this respect. A few places and subjects of fishery interest are illustrated by reproductions of photographs.]

9. Report upon the investigations of the U. S. Fish Commission steamer *Albatross* from July 1, 1889, to June 30, 1891. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XVII, for 1889–91, pp. 207–342. [Contains narrative of explorations as follows: Southeastern Alaska and coasts of Washington, Oregon, and California, season of 1889; fishing-grounds of Bering Sea, season of 1890; special scientific expedition off the west coast of Mexico, and of Central and South America, 1891.]
10. The fishing-grounds of Bristol Bay, Alaska: A preliminary report upon the investigations of the U. S. Fish Commission steamer *Albatross* during the summer of 1890. By Lieut. Commander Z. L. Tanner, U. S. Navy. Bull. U. S. Fish Comm., IX, for 1889, pp. 279–288. [Contains three charts on a scale sufficiently large to serve for navigation purposes, as follows: Bristol Bay and Alaska Peninsula, showing all the fishing-banks located in the former; Port Moller and Herendeen Bay, and the lower Nushagak River.]
11. A preliminary report on the fishes collected by the steamer *Albatross* on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIII, pp. 49–126, 1890.
12. Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and in the Gulf of California. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIV, pp. 539–566, 1891.
13. Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. Fish Comm., IX, for 1889, pp. 95–98. [Illustrated by maps of Alamitos Bay and Newport Entrance, California, and the vicinity of Guaymas, Mexico.]
14. Report upon the pearl fishery of the Gulf of California. By Charles H. Townsend. Bull. U. S. Fish Comm., IX, for 1889, pp. 91–94, 3 plates.
15. Report of observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. By Charles H. Townsend. U. S. F. C. Rept. 1889–91, pp. 343–372, plates 6–11.
16. Report on the fisheries of the Pacific coast of the United States. By J. W. Collins. Report U. S. Fish Comm., XVI, for 1888, pp. 3–269.
17. Three letters from Alexander Agassiz to the Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander. Agassiz, carried on by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. Mus. Comp. Zoöl., XXI, No. 4, pp. 185–200, 1891.
18. General sketch of the expedition of the *Albatross*, from February to May, 1891. By Alexander Agassiz. Bull. Mus. Comp. Zoöl., XXIII, No. 1, pp. 1–89, pls. 1–22, including a detailed chart of the explorations, 1892.

CHARTS.

19. Bristol Bay and Alaska Peninsula, Alaska, 1890. Illustrating investigations of 1890 on the fishing-grounds of Bristol Bay and adjacent waters. [Contained in No. 10.]
20. Port Moller and Herendeen Bay, Alaska, 1890. [Contained in No. 10.]
21. Lower Nushagak River, Bristol Bay district, Alaska, 1890. From a reconnoissance made in June, 1890. [Contained in No. 10.]
22. Alaska Peninsula and adjacent islands, 1888. To accompany report on Explorations of Alaskan fishing-grounds, in Bulletin U. S. Commission of Fish and Fisheries for 1888. Represents the fishing grounds south of the Alaska Peninsula from Unalaska to Middleton Island. [Contained in No. 8.]
23. Western coast of the United States from Umpqua River to the boundary. Illustrates the fishing investigations of 1888 on the coasts of Washington and Oregon, but is now incomplete, as much additional work has since been done in the same region. [Contained in No. 8.]
24. Reconnoissance of Cortes and Tanner banks, 1889. [Contained in No. 7.]
25. Hydrographic sketch of the Pacific, from the Gulf of California to northern Ecuador, with the track of the *Albatross*. [Contained in No. 18.]

COAST PILOTS AND CHARTS OF THE U. S. COAST AND GEODETIC SURVEY.

PACIFIC COAST PILOT.

California, Oregon, and Washington, 1889.—This edition does not embody any of the work accomplished by the steamer *Albatross*, having been published at too early a date.

Alaska.—The published edition of the Alaska Coast Pilot is exhausted, and a new edition is now in course of preparation. It will include the results of the *Albatross* investigations on the Alaskan coast to date.

SAILING CHARTS.

5000. San Diego to Point Arena, California. Scale, 1:1,200,000.
5050. San Francisco Bay to the Strait of Juan de Fuca. Scale, 1:1,200,000
6400. Seacoast and interior harbors of Washington, from Grays Harbor to Olympia, including Washington Sound. Scale, 1:300,000.
7000. Cape Flattery, Wash., to Dixon Entrance, Alaska. Scale, 1:1,200,000.
8000. Dixon Entrance to Cape St. Elias, Alaska. Scale, 1:1,200, 000.
8001. Inland passages, Olympia, Wash., to Mount St. Elias, Alaska. Scale, 1:1,200,000.
8500. Icy Bay to Semidi Islands, Alaska. Scale, 1:1,200,000.
S. San Francisco to Bering Sea. Scale, 1:3,600,000.
T. General chart of Alaska. Scale, 1:3,600,000.

GENERAL COAST AND HARBOR CHARTS.

California.

5100. San Diego to Santa Monica, including the Gulf of Santa Catalina. Scale, 1:200,000.
5200. Santa Monica to Point Conception, including the Santa Barbara Channel. Scale, 1:200,000.
5241. Anacapa Island and eastern part of Santa Cruz Island. Scale, 1:30,000.
5300. Santa Rosa Island to Point Buchon. Scale, 1:200,000.
5400. Point Buchon to Point Pinos. Scale, 1:200,000.
5487. Point Carmel to Point Pinos. Scale, 1:12,000. Adjacent to the southern end of Monterey Bay.
5491. Monterey Harbor. Scale, 1:40,000.
5498. Monterey Bay. Scale, 1:60,000.
5500. Point Pinos to Bodega Head, California. Scale, 1:20,000. Includes Monterey Bay and a part of the region off San Francisco.
5581. San Francisco Entrance. Scale, 1:40,000.
5599. Drake Bay. Scale, 1:40,000.
5600. San Francisco to Point Arena. Scale, 1:200,000. Includes a part of the region off San Francisco.
5618. Tomales Bay. Scale, 1:30,000.
5627. Bodega Bay. Scale, 1:30,000.
5700. Point Arena to Cape Mendocino. Scale, 1:200,000.
5800. Cape Mendocino to Point St. George. Scale, 1:200,000.

Oregon.

5900. Point St. George, California, to Umpqua River, Oregon. Scale, 1:200,000.
5952. Cape Orford and Reef. Scale, 1:40,000.
6000. Umpqua River to Cape Lookout. Scale, 1:200,000.
6100. Cape Lookout, Oregon, to Grays Harbor, Wash. Scale, 1:200,000.
6149. Approaches to the Columbia River. Scale, 1:200,000.

Washington

6100. Approaches to the Columbia River. Scale, 1:200,000.
6149. Approaches to the Columbia River. Scale, 1:200,000.
6265. Cape Flattery. Scale, 1:40,000.

Alaska.

8451. Middleton Island. Scale, 1:130,000.
8881. Semidi Island and Chirikof Island. Scale, 1:400,000.
8881. Shumagin Islands. Scale, 1:447,000, with the following harbor charts: Northwest Harbor, scale 1:122,000; Northwest and Yukon harbors, scale 1:64,000; Simeonof Harbor, scale 1:90,000; Eagle Harbor, scale 1:90,000; Falmouth Harbor, scale 1:65,000.
8891. Harbors in the Shumagin Islands, as follows: Sanborn Harbor, scale 1:40,000; Popof Strait and Humboldt Harbor, scale 1:40,000; Coal Harbor, scale 1:20,000; Zacharefskaia Bay, scale 1:100,000.
8891. Chignik Bay, Alaska Peninsula. Scale, 1:23,000.
8896. Alaska Peninsula and adjacent islands, from Coal Cape to Issannakh Strait. Scale, 1:596,000.
8901. St. Paul Harbor, Kadiak Island. Scale, 1:62,000.
8901. Sannak Islands and Reefs; scale 1:490,000. Acherk Harbor; scale, 1:31,000.
8901. Port Moller, Alaska Peninsula. Scale, 1:133,000.
8901. Iliuliuk Harbor, Unalaska. Scale, 1:9,400.
9007. Captain Bay, Unalaska. Scale, 1:43,000.

CHARTS OF THE UNITED STATES HYDROGRAPHIC OFFICE.

OCEAN CHARTS.

68. Bering Sea and Arctic Ocean.
526. North Pacific Ocean, Sheet I, from the coast of United States to 112° west longitude and from the equator to 29° north latitude, with plan showing streams, currents, and drifts in the Pacific Ocean.
527. North Pacific Ocean, Sheet II, from 110° west longitude to 162° west longitude and from the equator to 63° north latitude.
528. North Pacific Ocean, Sheet III, from 160° west longitude to 150° east longitude and from the equator to 60° north latitude.
823*a*. South Pacific Ocean, Sheet I, eastern sheet, upper part. Includes the Galapagos Islands.

COAST CHARTS.

904. West coast of North America. Latitude 51° 30′ to 55° 30′ N., including the Queen Charlotte Islands, Heceta Strait, and Dixon Entrance.
903. West coast of North America. Juan de Fuca Strait to Queen Charlotte Islands, including Vancouver Island.
961. Southern part of Vancouver Island and adjacent coast. (From Barclay Sound on the south to Nanoose Harbor on the north, and including Juan de Fuca, Haro, and Rosario straits, the adjacent islands, and coasts of Washington and British Columbia from Cape Flattery to Burrard Inlet).
1006. Pacific coast of the United States and Mexico. San Francisco, Cal., to San Blas, Mexico. [Includes Gulf of California, the Revillagigedo Islands, etc.]
1007. Pacific coast of Mexico and Central America. San Blas to Panama and the west coast of the United States of Colombia to Port Buenaventura.
619. West coast of Mexico and Gulf of California. Latitude 29° 15′ N., to San Diego and mouth of the Colorado River, including both coasts of Lower California.
620. West coast of Mexico and Gulf of California. Latitude 26° N. to 29° 20′ N., including both coasts of Lower California.
621. West coast of Mexico and Gulf of California. Cape San Lucas and Mazatlan to latitude 26° N., including both coasts of Lower California.
622. West coast of Mexico. Mazatlan to Tenacatita Bay, and the Revillagigedo Islands.
933. West coast of Mexico. Chamela Bay to Maldonado.
932. West coast of Mexico. Maldonado to Ocos River.
1176. Coasts of Colombia and Ecuador. Panama to Cape San Francisco.
1018. West coast of Central America. Burica Point to Morro Puercos.
1019. West coast of Central America. Morro Puercos to Cocalita Point, Gulf of Panama.
1216. The Hawaiian Islands, with the islands and reefs to the westward. [Contains data from cable survey by steamer *Albatross*, winter of 1891–92.]
867. Southern part of Oahu [Contains data from cable survey by steamer *Albatross*, winter of 1891–92.]

LIST OF CHARTS AND OTHER PUBLICATIONS BEARING UPON THE FISHERY INVESTIGATIONS OF THE STEAMER ALBATROSS.

The Fish Commission publications here enumerated include only the reports descriptive of the hydrographic and fishery investigations of the *Albatross*, and a few papers from the "Fisheries and Fishery Industries of the United States," which contain a complete review of all that was known respecting the marine fisheries and fishing-grounds of the Pacific coast down to 1882. The charts of the U. S. Coast and Geodetic Survey and Hydrographic Office of the Navy are those on which the soundings of the *Albatross* have been plotted, and they also otherwise illustrate the regions over which her work has been extended. The most useful charts for the Alaskan coast, in connection with this subject, are Fish Commission Nos. 19, 20, 21, 22; Coast Survey, S and T, together with the several harbor charts, and Hydrographic Office chart 68. The general coast charts of the Coast Survey, on a scale of 1:200,000, constitute a uniform series covering the entire coast line of Washington, Oregon, and California, and contain a sufficient amount of detail to answer for most fishing purposes. For the work accomplished south of California, the Hydrographic Office charts and Fish Commission No. 25 should be consulted.

REPORTS AND CHARTS OF THE U. S. FISH COMMISSION.

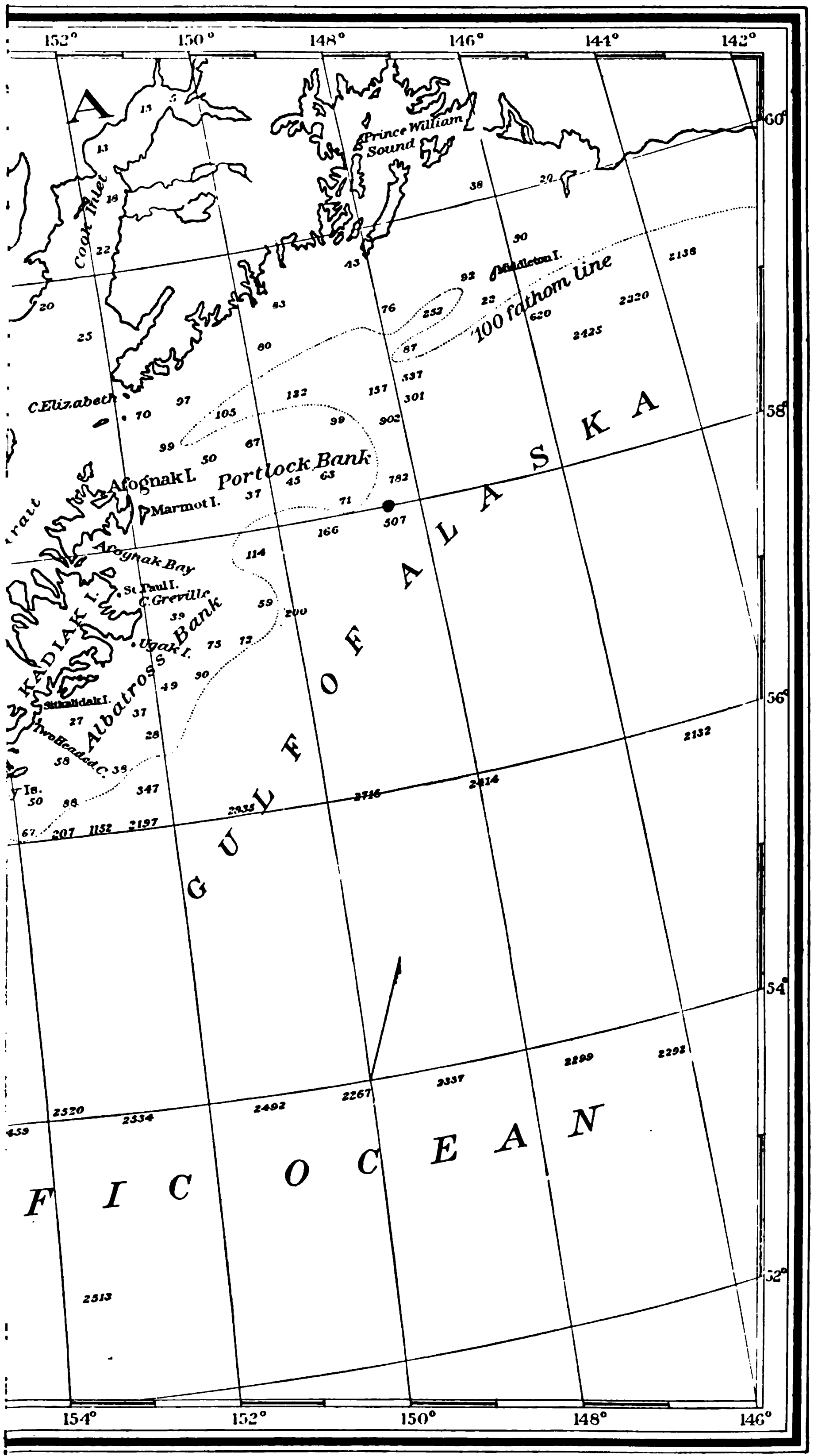
REPORTS.

1. The fishery resources and fishing-grounds of Alaska. <By Tarleton H. Bean. The Fisheries and Fishery Industries of the United States. By George Brown Goode and a staff of associates. (U. S. Fish Commission.) Section III, pp. 81–115, 1887.
2. The cod fishery of Alaska. By Tarleton H. Bean. *Idem.* Section V, vol. I, pp. 198–224, 1887.
3. [Discussions of the economic fishes of the Pacific coast of the United States.] By David Starr Jordan. *Idem.* Section I, 1884. The discussion of the different economic species will be found under the several natural groups to which they respectively belong.
4. The sea fishing-grounds of the Pacific coast of the United States from the Straits of Fuca to Lower California. By David S. Jordan. *Idem.* Section III, 1887, pp. 79, 80.
5. The fisheries of the Pacific coast. By David Starr Jordan. *Idem.* Section II, 1887, pp. 591–630.
6. Report on the work of the U. S. Fish Commission steamer *Albatross* from January 1, 1887, to June 30, 1888. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XV, for 1887, pp. 371–435. [Includes the narrative of the cruise from Washington, D. C., to San Francisco, Cal., 1887–88.]
7. Report on the investigations of the U. S. Fish Commission steamer *Albatross* for the year ending June 30, 1889. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XVI, for 1888, pp. 395–512. [Contains narrative of investigations off the south side of the Alaska peninsula, summer of 1888; off the coasts of Washington, Oregon, southern California, and Lower California, and in the Gulf of California, 1888 and 1889. Includes also report of A. B. Alexander, fishery expert, and chart of Cortes and Tanner banks.]
8. Explorations of the fishing-grounds of Alaska, Washington Territory, and Oregon, during 1888, by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. U. S. Fish Comm., VIII, for 1888, pp. 1–95. [In this report the investigations of 1888 are discussed in geographical sequence beginning at the north. It contains two large charts, one covering the fishing-grounds off the south side of the Alaska Peninsula, the other showing the operations on the coasts of Washington and Oregon as far south as Tillamook Rock and on Heceta Bank. The latter chart is now incomplete, much additional work having been done in that region during subsequent years. Recent Coast Survey charts, enumerated below, give full data in this respect. A few places and subjects of fishery interest are illustrated by reproductions of photographs.]

9. Report upon the investigations of the U. S. Fish Commission steamer *Albatross* from July 1, 1889, to June 30, 1891. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XVII, for 1889–91, pp. 207–342. [Contains narrative of explorations as follows: Southeastern Alaska and coasts of Washington, Oregon, and California, season of 1889; fishing-grounds of Bering Sea, season of 1890; special scientific expedition off the west coast of Mexico, and of Central and South America, 1891.]
10. The fishing-grounds of Bristol Bay, Alaska: A preliminary report upon the investigations of the U. S. Fish Commission steamer *Albatross* during the summer of 1890. By Lieut. Commander Z. L. Tanner, U. S. Navy. Bull. U. S. Fish Comm., IX, for 1889, pp. 279–288. [Contains three charts on a scale sufficiently large to serve for navigation purposes, as follows: Bristol Bay and Alaska Peninsula, showing all the fishing-banks located in the former; Port Moller and Herendeen Bay, and the lower Nushagak River.]
11. A preliminary report on the fishes collected by the steamer *Albatross* on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIII, pp. 49–126, 1890.
12. Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and in the Gulf of California. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIV, pp. 539–566, 1891.
13. Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. Fish Comm., IX, for 1889, pp. 95–98. [Illustrated by maps of Alamitos Bay and Newport Entrance, California, and the vicinity of Guaymas, Mexico.]
14. Report upon the pearl fishery of the Gulf of California. By Charles H. Townsend. Bull. U. S. Fish Comm., IX, for 1889, pp. 91–94, 3 plates.
15. Report of observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. By Charles H. Townsend. U. S. F. C. Rept. 1889–91, pp. 343–372, plates 6–11.
16. Report on the fisheries of the Pacific coast of the United States. By J. W. Collins. Report U. S. Fish Comm., XVI, for 1888, pp. 3–269.
17. Three letters from Alexander Agassiz to the Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander. Agassiz, carried on by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. Mus. Comp. Zoöl., XXI, No. 4, pp. 185–200, 1891.
18. General sketch of the expedition of the *Albatross*, from February to May, 1891. By Alexander Agassiz. Bull. Mus. Comp. Zoöl., XXIII, No. 1, pp. 1–89, pls. 1–22, including a detailed chart of the explorations, 1892.

CHARTS.

19. Bristol Bay and Alaska Peninsula, Alaska, 1890. Illustrating investigations of 1890 on the fishing-grounds of Bristol Bay and adjacent waters. [Contained in No. 10.]
20. Port Moller and Herendeen Bay, Alaska, 1890. [Contained in No. 10.]
21. Lower Nushagak River, Bristol Bay district, Alaska, 1890. From a reconnoissance made in June, 1890. [Contained in No. 10.]
22. Alaska Peninsula and adjacent islands, 1888. To accompany report on Explorations of Alaskan fishing-grounds, in Bulletin U. S. Commission of Fish and Fisheries for 1888. Represents the fishing grounds south of the Alaska Peninsula from Unalaska to Middleton Island. [Contained in No. 8.]
23. Western coast of the United States from Umpqua River to the boundary. Illustrates the fishing investigations of 1888 on the coasts of Washington and Oregon, but is now incomplete, as much additional work has since been done in the same region. [Contained in No. 8.]
24. Reconnoissance of Cortes and Tanner banks, 1889. [Contained in No. 7.]
25. Hydrographic sketch of the Pacific, from the Gulf of California to northern Ecuador, with the track of the *Albatross*. [Contained in No. 18.]



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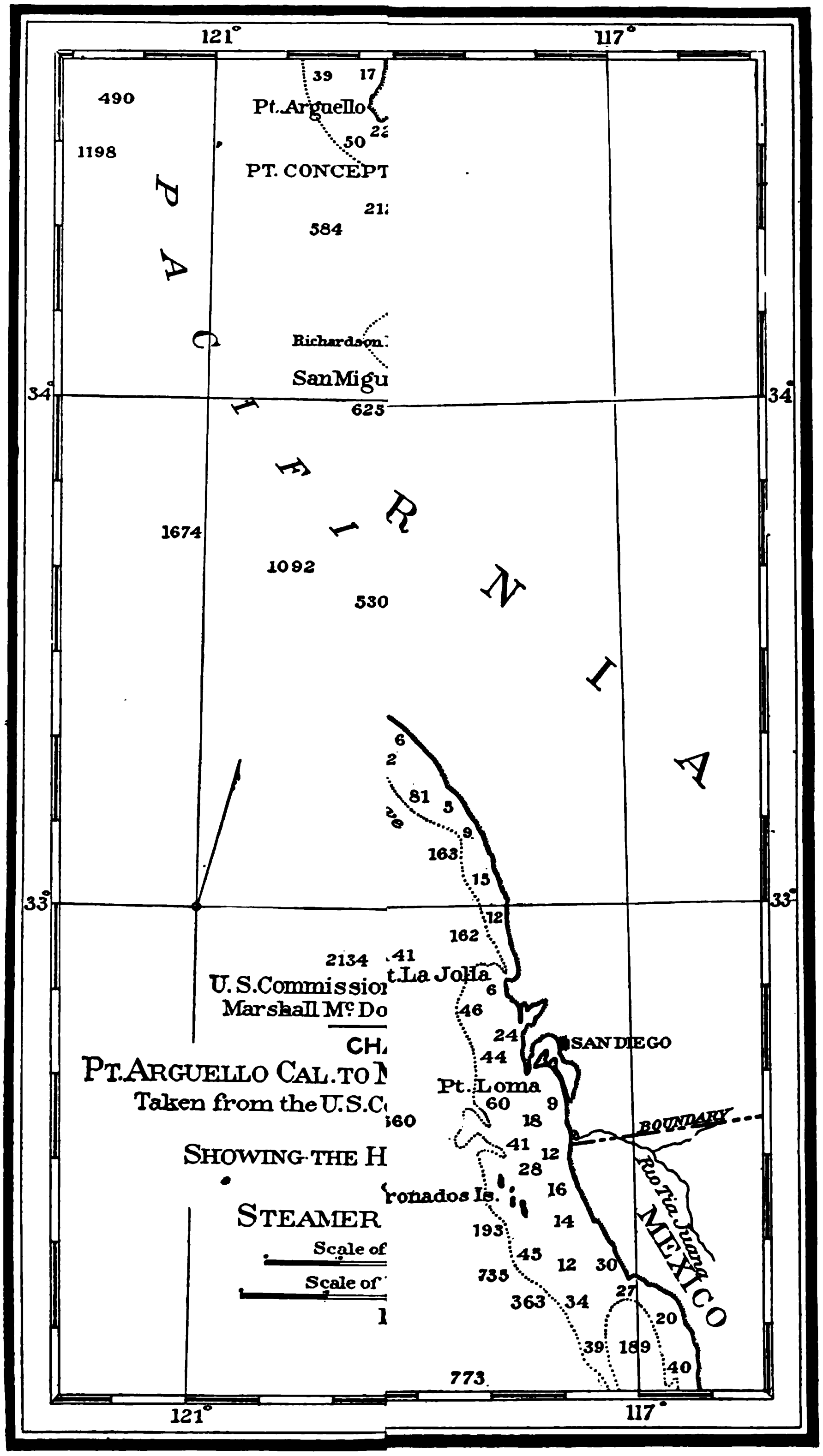
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5.—THE OYSTER INDUSTRY OF MARYLAND.

INTRODUCTORY NOTE.

Among the fishery industries of the United States the oyster fishery ranks first in importance, and of the States engaging in this fishery Maryland occupies the most prominent position. The attention given to oyster fishing and oyster cultivation in recent years has been one of the most prominent features of the fishery industries, and has resulted in a great and growing demand for practical literature on the subject, which it has been the aim of the U. S. Commission of Fish and Fisheries to supply.

The present paper is one of a series of special articles relating to the oyster industry which this Commission has issued or has in course of preparation. From a very early period in its history, the Commission has constantly had in view the importance of the oyster as a food product and has carried on inquiries addressed to the biological, physical, economical, and statistical aspects of the industry. The previous reports presented by the Commission are very numerous and cover almost every phase of the subject. Among the recently issued papers the following relating to the Atlantic coast may be mentioned: "Notes on the Oyster Industry of Connecticut," "The Physical and Biological Characteristics of the Natural Oyster-Grounds of South Carolina," "An Investigation of the Coast Waters of South Carolina with reference to Oyster-Culture," and "Report on the Coast Fisheries of Texas."

In addition to the work represented by the foregoing reports, biological and topographical surveys have been conducted in Long Island Sound, Chesapeake Bay, and Galveston Bay, full accounts of which have not yet been printed. The oyster fishery of the west coast has been dealt with in two special papers, "Report upon Certain Investigations relating to the Planting of Oysters in Southern California" and a "Report of Observations respecting the Oyster Resources and Oyster Fishery of the Pacific Coast of the United States." For the purpose of instituting comparisons and affording opportunity to apply the methods of cultivation employed in other countries so far as they may be applicable to the United States, inquiries have also been conducted in all the countries of Europe having oyster fisheries, and two reports based on these studies have been printed, one entitled "The Present Methods of Oyster-Culture in France," the other a "Report on the European Methods of Oyster-Culture." In the regular descriptive and statistical fishery reports of the Commission relating to the different geographical coast sections of the country, the oyster fishery has also received due notice.

This article is a contribution to the economic phase of the oyster industry. It emanates from the Division of Statistics and Methods of the Fisheries of this Commission and is based largely on the personal observations and inquiries of the author, Mr. Charles H. Stevenson. The report consists of a history of the oyster industry of Maryland from early times, a review of the legislation by which the fishery has been regulated, a description of the oyster-grounds of the State, a detailed account of the methods employed in taking oysters, a notice of the progress of oyster-culture in Maryland, a history of the State oyster police and of the oyster-revenue services, statistical tables showing by counties the extent of the industry in recent years, and a discussion of the transporting, packing, and marketing trades.

The extent of the oyster industry of Maryland in the season of 1891–92, as determined by the investigations carried on by this office, may be summarized as follows: The number of persons engaged in various capacities was 33,388; of these, 10,813 were employed in tonging oysters, 5,059 in dredging, 3,757 in scraping, 1,651 in transporting only, and 12,108 as shore and factory hands. The vessels employed numbered 1,624; the number of boats used was 6,554; the vessels and boats, with their outfit and apparatus, were worth $2,618,745. The capital invested in the shore and accessory property devoted to the packing and marketing trades was $4,650,500. The total investment in the industry was therefore $7,269,245. The quantity of oysters taken and sold was 11,632,730 bushels, for which the fishermen received $5,866,120.

The report is accompanied by 15 plates illustrating fishing methods and appliances and a chart showing the location of the oyster-grounds and indicating the respective areas on which tonging, scraping, and dredging are authorized.

MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries.

WASHINGTON, D. C.,
November 29, 1893.

THE OYSTER INDUSTRY OF MARYLAND.

BY CHARLES H. STEVENSON.

INTRODUCTION.

Few branches of the American fisheries have been the subject of so much discussion and are so little understood as the oyster industry of the State of Maryland. For fully eighty years this fishery, by reason of its condition and importance, has demanded the attention of the tide-water residents of that State, and at nearly every session of the Maryland general assembly since 1820 it has been one of the most fruitful subjects for legislative enactments; yet a system of regulation satisfactory either to the oystermen or to the State at large has not been established, and at no previous time in the history of the fishery has it received the amount of attention as at present.

A discussion of this industry is especially interesting because it is the most extensive and valuable oyster fishery in the world. In European countries and in the majority of the oyster-producing States of America the food market receives the greater portion of its supplies from private grounds, the regulations governing the common or free fisheries being largely subsidiary to the needs of the industry on the private areas. Maryland, however, has persistently refused to encourage an extensive development of private oyster fisheries, devoting instead all its energies toward conserving and protecting the free fishery on the public domain.

The purpose of this paper is to discuss all branches of the oyster industry of Maryland, from the operations of the oystermen to the preparation of the marketable products, the investigation being chiefly from an industrial point of view. Brief but complete notice is taken of the regulations that have surrounded the industry since its inception, as it exhibits the constant efforts made by a people during a period of seventy years to preserve the prosperity of a common fishery. Reference is made for the first time to the planting or bedding operations conducted in the Sinepuxent Bay, and the small business done in this line in other portions of the State. Only the actual and relative conditions of the industry in its various branches are discussed, and no attempt is made to add to the interest or volume of the paper by describing the many unique and novel methods and customs prevalent in certain localities, unless the same have some bearing upon the prosperity of the industry.

Probably no State in the Union has for its area so great an inland water-surface as Maryland. Of the twenty-three counties in this State, the oyster fishery is prosecuted from eleven, in which, because of the innumerable tributaries of the Chesapeake extending into the land, there are few localities removed a greater distance than 6 miles from navigable water, thus bringing all the residents into close contact with the fisheries. The total population in 1890 of these eleven counties was 219,307, and the oyster industry is by far the principal means of support. This does not include the city of Baltimore with its extensive dredging, transporting, and marketing interests, giving direct employment to 11,000 persons and support to many times that number.

The dependence of a large proportion of the citizens of Maryland upon this fishery for a livelihood, and the immense resources it furnishes for the profitable employment of capital and labor, demand that the fullest inquiry be made into its needs and conditions, and should cause everyone interested either in the welfare of Maryland or in the fisheries of America to be extremely solicitous that no permanent injury to it should be permitted and that every available means be utilized toward maintaining and, if practicable, increasing the productive capacity. Neither is the interest in this industry limited to the State of Maryland, for nearly every locality in America is to some extent dependent for the abundance and cheapness of its oyster supply on the product of the Chesapeake, and this interest is also shared by the foreign consumer of the canned product.

In every region of the world where the oyster industry has assumed any commercial importance it has passed, or is apparently passing, through the following four stages: First, the natural reefs in their primitive condition and furnishing the entire supply of oysters; second, those reefs somewhat depleted and producing small oysters, many of which are transplanted to private grounds and under individual protection permitted to mature; third, the public beds so far depleted that the supply available is very irregular and uncertain and consists almost entirely of small oysters which are transplanted to private areas; fourth, the entire dependence of the industry on areas of ground under individual ownership or protection.

In Europe the greater number of the oyster-producing localities are in the condition of the fourth stage. In America, with apparently a more hardy oyster, the natural advantages greater, and the fisheries not so long continued, the industry still depends largely on the public reefs. But were it not for the supply of seed oysters obtained from more southern waters all those States north of Connecticut would be practically in the condition of the fourth stage, the public reefs in that region being almost totally destroyed. Connecticut, New York, New Jersey, and Delaware, while obtaining large quantities of small oysters from the Chesapeake and other localities, are rapidly passing from the third to the fourth condition. The oyster industry of Chesapeake Bay, both in Maryland and Virginia, is in the second stage, but the history of the fishery in other States and countries excites grave fears as to its long continuance in this condition.

In Maryland the oyster industry is at present almost totally dependent on the public reefs, and there are two great interests in the fishery which, for nearly a century, have been antagonistic to each other, viz, the tongmen and the dredgers with their allies the scrapemen, and these three unitedly wage common war on the planters. The dispute between the tongmen and dredgers is of economic origin, being due to the improved machinery of the latter surpassing that of their rivals. The common objection to the planters is founded in the belief that their operations constitute an encroachment upon the public customs, and that the free fishery on the public reefs may thereby be seriously restricted. These class feelings have had much to do with preventing a satisfactory understanding of the fishery and its regulation in a manner acceptable to the State at large.

In studying this fishery in Maryland and comparing its needs and conditions with those of this industry in other localities, consideration must be taken of the enormous extent to which, during the last twenty-five years, it has been prosecuted. The water area of Maryland is the greatest oyster-producing region in the world, and the output of the industry is fully equal in value to one-sixth of the product of all the fisheries of the United States combined and gives employment to one-fifth of the persons engaged therein.

For purposes of comparison the following tabular statement is submitted, showing either approximately or by latest returns the catch of oysters from public and private areas in each of the various States of America and the principal foreign oyster-producing countries:

Table showing the oyster product of the world.

State or country.	No. of bushels.	Value.	Year.
Massachusetts	58, 007	$81, 938	1892
Rhode Island	172, 945	241, 978	1892
Connecticut	1, 940, 174	1, 426, 244	1892
New York	2, 611, 062	2, 748, 509	1891
New Jersey	2, 632, 117	1, 746, 930	1892
Pennsylvania	132, 380	101, 850	1892
Delaware	175, 332	73, 863	1892
Maryland	11, 632, 730	5, 866, 120	1892
Virginia	5, 984, 636	2, 487, 638	1891
North Carolina	807, 260	175, 567	1890
South Carolina	63, 150	23, 204	1890
Georgia	224, 355	40, 520	1890
Florida	468, 431	93, 692	1890
Alabama	481, 070	107, 812	1890
Mississippi	806, 478	166, 672	1890
Louisiana	841, 585	299, 896	1890
Texas	440, 800	127, 990	1890
Washington	142, 730	127, 000	1892
Oregon	2, 500	3, 125	1892
California	178, 645	698, 257	1892
Total for United States	29, 796, 387	16, 638, 805	
Canada	152, 580	183, 846	1891
British Isles	2, 760, 000	6, 200, 000	Approx.
France	2, 000, 000	5, 000, 000	Do.
Holland	70, 000	440, 000	Do.
Italy	65, 000	200, 000	Do.
Germany	13, 000	75, 000	Do.
Miscellaneous	400, 000	600, 000	Do.
Total for foreign countries	5, 460, 580	12, 698, 846	
Grand total	35, 256, 967	29, 337, 651	

It is thus observed that the quantity of oysters produced in Maryland is one-third of the total product of the world and more than twice as great as that of all foreign countries combined.

This report is largely the result of observations and inquiries made by the writer, as an agent of the U. S. Fish Commission, during extended trips through the tide-water counties of Maryland and of examinations of the voluminous State and county records. Liberal and valuable assistance has been accorded the work by the State and county officials and many other persons in positions to be informed respecting the oyster industry. Especial acknowledgment is made to Gen. Joseph B. Seth, sometime commander of the State fishery force, to Mr. William D. Platt, an extensive oyster-dealer of Baltimore, Marion deK. Smith, esq., comptroller of the State treasury, Col. Thomas S. Hodson, and Conway W. Sams, esq. Acknowledgment is also due Mr. Daniel Bendann, of Baltimore, for the use of an excellent series of photographs illustrating the various phases of the oyster industry of Maryland.

GENERAL HISTORICAL NOTES.

In order that the present condition of the oyster industry of this State may be properly presented and understood, it is necessary to review its conditions and methods of prosecution in former years. There have been three great eras in the history of the oyster industry in Maryland, viz: First, from the settlement of the State to 1820, during which the fishery was in its infancy, subject to no restrictions or regulations whatever except those of nature and market demands, the product being very small; second, from 1821 to 1864, during which the use of dredges in catching oysters was interdicted and the wholesale shucking trade was established and considerably developed; third, from 1865 to the present date, in which a license system has been operative, authorizing the use of tongs, dredges, and scrapes under certain regulations, the places and times of their employment being restricted.

Prior to 1820.—The heaps of oyster shells found in some places along the shores of the Chesapeake indicate that these mollusks had for a long time been utilized for food purposes by the Indians; and the writings of the early settlers of and travelers to this part of the country make reference to the fact that the aborigines at times furnished them with oysters in exchange for trinkets and other commodities. The Chesapeake colonists appear to have given little attention to them. An explanation for this is probably found in John Smith's "Advertisements for Unexperienced Planters," published in 1631, in which he explains the reasons why the early settlers of the Chesapeake did not engage in fishing by stating: "Now although there be * * * Fish in the rivers * * *, yet the rivers are so broad * * * and we so unskillful to catch them, we little troubled them nor they us."

There are many reasons for the belief that, for years after the settlement of Maryland, oysters were regarded as of little value for food purposes. Diligent search among the early colonial records has resulted in the finding of but one reference to this product. This reference, which is certainly depreciatory, occurs in the depositions made in the famous Claiborne suit of about 1680, in which the "Kent Islanders" cited, among their grievances and the hardships which they had to endure, that their supply of provisions becoming exhausted it was necessary for them, in order to keep from starvation, to eat the oysters taken from along the shores.

As no further mention of them is found among the voluminous colonial papers, it is reasonable to suppose that after the settlement of Maryland a long time elapsed before oysters entered largely into the food supplies of the inhabitants, hence there was little object in catching them. During the war of 1812, occasional reference was made in the newspapers of that period to the part played by the oystermen of the Chesapeake in harassing the British fleet in the bay, from which it is evident that at that time the fishery was of some consequence.

It appears from records and traditions that a large portion if not the greater quantity of the oysters then caught were transported by vessels to Northern markets, a considerable demand for them having been developed in the New England States; and, beginning about 1808, a number of vessels each season transported several cargoes to Fair Haven, Conn. The vessels resorted to the reefs situated in the lower part of the bay, and obtained cargoes either by dredging or by purchasing from the tongmen living along the shores, who oystered especially for those vessels. It was by the transporters that the use of dredges was largely extended in Maryland waters, this being to some extent necessary for the transportation trade, when the State of Virginia, by act dated January 9, 1811 (Laws, Va., 1810-11, ch. xvii), interdicted the use of these implements within the waters of that State. No wholesale markets existed along the shores of the Chesapeake for the handling of oysters, and it is probable that the local consumption was very small.

From 1820 to 1864.—The quantity of oysters for the Northern markets, while not large in view of the present knowledge regarding the productiveness of these reefs, was sufficient to alarm the oystermen of that time lest their industry should thereby become totally destroyed. These apprehensions resulted, in 1820 (L. 1820-21, ch. 24), in the earliest enactment of the general assembly of Maryland regulating or affecting the oyster industry, the annual product of the State at that time scarcely exceeding, if it equaled, 500,000 bushels. Because of the insight it offers into the fishery as it then existed, the preamble to this enactment is here given:

> Whereas it is represented to the general assembly that a great number of large vessels from the Northern and Middle States frequent our waters for the purpose of transporting oysters to those States; and whereas well-grounded apprehensions are entertained of the utter extinction of oysters in the State, as well in consequence of the immense quantity thereof exported as the destructive implements used in catching them: Therefore, etc.

This enactment prohibited, under penalty of a fine of $20 or sixty days' imprisonment, the use of any implements in catching oysters within the State other than the ordinary tongs, and also the transportation of oysters out of the State in vessels not owned wholly for the preceding twelve months by a citizen of the State, or placing oysters on board any such vessel to be transported. Because of the great expanse of water territory, and the difficulty of enforcing the law without competent physical force upon the bay, this enactment did not fully prevent the continuation of the trade by Northern vessels.

During the next session of the general assembly an exception was made (L. 1821-22, ch. 107) to the law of 1820, and permission was given to each citizen of the State of Delaware living within 3 miles of the northeast branch of the Nanticoke River to catch oysters from that branch of said river in quantities not exceeding 30 bushels per day; a privilege which they enjoyed for many years and to which may be due in some respects the extensive oyster-shucking trade now prosecuted at Seaford. This is one of the very few instances in which a State has, by legislative enactment, authorized non-residents to take fishery products from within its borders.

On February 16, 1830 (L. 1829-30, ch. 87), an important enactment was made embodying almost the first oyster-planting law operative in America. This act authorized citizens of the State to preëmpt, under certain regulations, an acre of ground naturally unproductive of oysters, for the purpose of planting and growing oysters and other shellfish thereon. It also granted to the owner of lands bordering a creek less than 100 yards in width at its mouth the exclusive right to the use of the same for a similar purpose. The productiveness of the natural reefs having apparently continued to decrease since the enactment of 1820, this act further interdicted the use of tongs having more than six teeth on a side; but this restriction, so far as it applied to the waters of the Eastern Shore, was repealed at the same session of the legislature, the prohibition of their use on the Western Shore remaining until 1834. The act also provided that no persons other than citizens of the county or counties bordering on any river or bay should catch oysters within 300 yards of low-water mark of either shore of said river or bay. In this provision originated the distinction between "county waters" and "State waters," the latter being such areas as are open for the use of any resident of the State—a distinction which, though modified and changed to a considerable extent, has remained to the present day.

Some difficulty was experienced in enforcing this enactment, and at the next legislative session (L. 1831–32, ch. 249) more easily applied penalties and court regulations were provided for its enforcement in the waters of the Eastern Shore, and in the following year the same provisions were applied to the Western Shore (L. 1832–33, ch. 265). The necessity for these provisions was intimated in the preamble to the first one, as follows:

> Whereas the protection of oysters in the waters of this State is a subject in which the citizens thereof are deeply concerned, and the legislature of Maryland by sundry laws passed for that purpose have sought to secure the advantages resulting from that article of trade, which have fallen short of the object they were designed to accomplish; and
>
> Whereas the citizens of this and other States infesting said waters have continued to take and carry away oysters in violation of the laws upon this subject enacted; and it is justly apprehended that oysters in the waters of the State will be destroyed, not less by the immense number carried away than by the destructive implements used in taking them; and
>
> Whereas the navigation of many creeks has been obstructed by the citizens of this and other States by means of the heaps of the refuse thrown into the waters of said creeks in the process of picking [culling] the oysters for market, to the great injury of the good people of this State. * * *

During the twenty-four years following 1830 few important changes were made in the regulations of the fishery, but it was an era of great development in the extent of the industry. The opposition to the transportation of oysters out of the State and the cost of doing so when that opposition was overcome induced a number of oyster marketmen from New England to establish shucking-houses in Baltimore for shipment of the Chesapeake stock throughout the country, and the increased demand naturally led to an extension of the fishery. The first of these houses was established in 1836 and others were started within a few years.

In 1840 it was estimated that the quantity of oysters used by the shucking trade during the previous season amounted to 710,000 bushels, and there was a large additional quantity consumed along the shores. During the years immediately following 1840 many of the large reefs in the Tangier region were discovered, resulting in a greater development of the fishery in that section. About 1846 the canning of oysters was begun and the extension of this branch of the trade rapidly increased the demand for the product of the reefs.

In the meanwhile, however, additional restrictions were placed on the fishery, of which the following were the most important. In 1836 (L. 1835–36, ch. 216 and ch. 260) the catching or burning of oysters for purposes of fertilizing land was prohibited in portions of Dorchester and St. Mary counties, and in 1840 (L. 1839–40, ch. 103) the same practice was prohibited in Somerset County. By act of 1837–38, ch. 310, it was made unlawful for any person other than residents of the counties bordering on the same to catch oysters within 500 yards of low-water mark in any waters of the State, and in cases in which a creek or river is the divisional line between two counties the privilege of taking oysters therefrom belonged to the residents of those counties in common and to none others. By act of 1845–46, ch. 240, the catching of oysters in the waters of Worcester County between April 13 and September 1 of any year was interdicted, this being the first close season operative in Maryland and one of the earliest in America.

In 1852 (ch. 57) the removal of empty shells from any oyster reefs in Worcester County for any purpose whatever was prohibited. These shells were generally manufactured into lime. The quantity of small oysters and shells used from 1810 to 1860 for fertilizing purposes after being burned, or without that treatment, is surprisingly large. The oysters together with the empty shells and débris, or the "run of the rock," could be purchased in large quantities for 2 to 4 cents per bushel, a tongman being able to catch from 40 to 100 bushels per day. The stock was of the same grade as now sells for 10 to 20 cents per bushel for planting purposes. The lime was worth from 3 to 8 cents per bushel, and was spread over the land sometimes as plentifully as 75 or 100 bushels to the acre. By this method of treatment large areas of land that produced nothing but June grass were made very productive by further cultivation. The use of oysters for this purpose continued in some localities of Maryland even as late as 1875, and it is stated on reliable authority that in 1873 oysters were sold at 2 cents per bushel in Talbot County for this use.

In 1854 (L. 1854, ch. 4) a material change was effected in the fishery, and the use of the reefs of the State by the tongmen exclusively was modified by it being made lawful for citizens of Somerset County to take oysters with small dredges or scrapes in any of the waters of that county not part of a creek and not within 200 yards of the shore and not less than 21 feet deep. Before engaging in scraping (as this form of oystering when prosecuted within the limits of a county is now designated) each vessel was required to obtain a license at a cost of $15, the revenue derived therefrom being applied to the school fund of the county. This was the first oyster license law operative in Maryland, and almost the first in America.

The military operations in Maryland and Virginia from 1861 to 1865, and the consequent disorganization of the oyster trade, put a temporary check on the advance of the fishery. But the market demand for oysters increased, being due largely to the extension of the canning trade during that period, and consequently the prices ruled high, the average received by the oystermen in 1863–64 and 1864–65 being about 70 cents per bushel. This resulted in great prosperity to those fishermen who were successful in continuing their operations.

From 1865 to 1893.—This period practically covers the time in which the industry has been of great extent and importance. The discontent among the oystermen of other counties at the special privilege enjoyed by the residents of Somerset under the act of 1854 (ch. 4), the high rate at which oysters were selling by reason of the recent military operations and the fact that (by means of tongs) oysters in depths of water greater than 23 feet could not readily be obtained, together with the great difficulty in enforcing the law then existing, led in 1865 (ch. 181) to a repeal of the entire body of the general law affecting the oyster industry and the enactment of another in lieu thereof, the general features of which have remained to the present time.

The principal changes effected by the new law were as follows: It required that no person should engage in catching oysters within the waters of the State for purposes of sale with any implement whatever without first having obtained an annual license for the boat or vessel employed. For every boat engaged in tonging, the owner thereof was required to pay a license fee of $5. The fee for dredging was at the rate of $5 for each ton of measurement of the vessel employed, and the use of dredges was authorized only from September 1 to June 1, and within specified portions of the Chesapeake Bay. All license fees were to be paid into the State treasury, and no steamboat or steam machinery was permitted to be used in catching oysters.

The annual oyster product of the river and tributaries during the last five seasons has averaged about 1,750,000 bushels, for which the fishermen have received $740,000, an average of 43,750 bushels and $18,500 to the square mile. The average quantity per square mile obtained in this region is greater than that of any other locality in Maryland, but the average value of the product per square mile is surpassed by the yield in the Patuxent and Tangier regions. The Choptank oysters are much smaller than those from the Tangier region and are among the cheapest obtained in Maryland. Large quantities of them are transported north each spring for planting purposes; and it is reported that as late as 1879 vessels loaded with planting stock from this river at a cost not exceeding 5 cents per bushel, the oysters being, of course, unculled.

The citizens of Dorchester and Talbot counties enjoy the exclusive use of the Choptank River reefs in common, but those of the former county engage more extensively in oystering. The use of scrapes was first authorized in 1870, and since then a very great increase has taken place in the area of the oyster beds, and the shape of the oysters has become more uniform, rendering them more valuable from an economic standpoint.

Two large oyster-marketing ports, Cambridge and Oxford, utilizing annually about 600,000 and 300,000 bushels, respectively, are located on this river.

Eastern Bay.—Eastern Bay is situated largely within the counties of Talbot and Queen Anne, the remaining portion being a part of the "State waters." The area situated within "county waters" approximates 73 square miles; and, of that portion situated within the limits of Talbot County, about 7 square miles are utilized by a scraping fleet, the remaining area being reserved for tonging. The greatest depth of water is about 10 fathoms, the average being from 12 to 20 feet. The area more or less thickly covered with natural oyster-grounds, which are much scattered, is about 26 square miles. The average annual product of that portion within "county waters" is about 500,000 bushels, for which the oystermen receive about $250,000, an average of 19,230 bushels and $9,615 per square mile.

The Eastern Bay oysters are somewhat larger than the Choptanks and are sold at almost as high a price as the Tangiers. The only wholesale oyster ports on the shore of this bay are St. Michael and Claiborne, which handle annually about 225,000 and 35,000 bushels, respectively, nearly all the rest of the catch going to Baltimore.

Chester River.—This river, the northernmost and smallest of the four large coastal indentations on the Eastern Shore, is situated entirely within the counties of Kent and Queen Anne. The area approximates 68 square miles, being but little smaller than the "county water" area of Eastern Bay, and the area of the natural oyster-beds is about 17 square miles. While in one or two places in this river the depth of water is about 11 fathoms, few oyster-reefs exist where the depth is greater than 23 feet; or if they exist they are little known and are of no value, as tonging only is authorized.

As the oyster fishery in this estuary had not been sufficiently developed to warrant the use of dredges prior to the anti-dredging regulation of 1820, this form of oystering has never been legally prosecuted in these waters, but it has, during recent years, been a favorite locality for the operations of those dredgers willing to run risks in encroaching upon the areas reserved for the tongmen.

The annual oyster product of the Chester River approximates 450,000 bushels, for which the oystermen receive about $235,000, an average of 26,470 bushels and $13,823 for each square mile of reefs. There are no large wholesale oyster markets on the shores of this river and the catch is marketed mostly at Baltimore.

protective measure in America, and in only one or two States is a provision of this kind operative, Maryland being almost the first to attempt the enforcement of such a regulation; indeed, restrictions as to the size of the oysters to be taken are not now very popular abroad. The reason for this is that in most of the other American States that have given attention to the oyster industry, as well as in the oyster-producing countries of Europe, the present regulations of the common fishery are auxiliary to the needs of the private or several fisheries, and the public-reef fishermen make no complaint, for they are thus enabled to market their small oysters among the planters.

As even the smallest oysters caught in Maryland could be utilized in the steaming-houses of that State, or sold for bedding in other localities, the fishermen found a market for all they took from the water and did not attempt to carefully cull and return the small ones to the beds to increase in size for another season. A 1½-inch cull law had been enacted in 1886 (ch. 569) for the waters of Somerset County, but the difficulty in enforcing a local law of this nature rendered it almost inoperative. The general cull law as operative at present is as follows:

> All oysters taken from any of the waters of this State (either with scoops, dredges, or any similar instruments, or tongs or rakes) shall be culled upon their natural bed or bar as taken, and all oyster shells, and oysters whose shells measure less than two and one-half inches in length, measuring from hinge to mouth, shall be included in said culling and replaced upon said bed or bar as taken.

This regulation required such a change in the practices of the oystermen who had been accustomed to market oysters of all sizes that it was at first regarded as a great hardship, and much difficulty was experienced in its enforcement, notwithstanding the fact that everyone recognized its value. In a letter to the Maryland Board of Public Works, which controls the State fishery force, the commander of that force wrote, under date of December 31, 1890, in reference to the cull law, as follows:

> At the last session of the legislature a bill was prepared and introduced, under the direction of the governor, which provided for a system of culling, so as to have the young oysters left on the bars to furnish seed for a future supply, and this act is now about the only law which tends at all to relieve the bars from complete destruction. But the bill had a rider put upon it in the shape of an amendment that has about broken it down. The amendment provides for the ascertainment of the quantity of marketable oysters in a cargo by dumping 1 bushel in every 50, and in the end culling this "dump," finding the percentage of shells and small oysters, and deducting this percentage from the full cargo. This percentage is never taken out; but, on the contrary, goes into the bins of the packers as so much clear gain to them. By this section the packers are in position of greatest benefit when the oysters are not culled, as they get all the culls free, and these have, in some instances, amounted to 300 bushels in a cargo of 1,200 bushels. I find all classes to agree with me in saying that the cull law should be vigorously enforced, and all as unanimous in both violating it and trying to screen violators from arrest by the fishery force.

An attempt was made by act of 1892 (ch. 278) to remedy the defects in the regulation of this provision, and, as it can be effectively enforced only at the oyster markets, provision was made for the appointment by the governor of one inspector at each of the wholesale ports, whose duty it is to properly enforce the cull law in his respective district. Their compensation, limited to $600 per annum, was to be derived from the imposition of a tax of one-tenth of 1 cent per bushel on all oysters purchased by every wholesale or retail dealer. Many of the dealers, however, refused to pay this tax, alleging that it is irregular, and only about $2,500 was paid in 1892–93, notwithstanding the fact that 10,000,000 bushels of oysters were handled. But each year the

The situation at present is as follows: Both Maryland and Virginia oystermen pursue their calling in any and every part of the river that they may choose outside of the tributaries. Even though operating side by side, the Maryland oystermen are supposed to work in accordance with Maryland laws, and those of Virginia comply with the statutes of that State, this being in accordance with the convention act of 1884 (ch. 76), which is now operative. The one pays $3 per ton license fee and the other $1 per ton.* The one is expected to cull out and return all oysters under 2½ inches in length, while the other may take all he can catch, without regard to size. The result is that there is practically no culling regulation in the Potomac; and this has had a bad effect upon the enforcement of the cull law in other portions of Maryland. This condition of affairs in the Potomac constitutes a serious obstacle to the proper enforcement of the oyster laws of the State. The license laws and the close-season regulations, however, are very generally observed in the Potomac.

The area of this river from its mouth to the southern border of Prince George County is 358 square miles. In addition to this, the tributaries situated in the limits of St. Mary and Charles counties have an area of 37 and 21 square miles, respectively, in which only the tongmen of those respective counties are authorized to oyster, giving a total of 416 square miles. The area of oyster reefs approximates 42 square miles in the "State waters" and 7 in the tributaries situated within the "county waters." The average annual product of these reefs is about 1,600,000 bushels, valued at $700,000, of which about 500,000 bushels are obtained by the oystermen of Virginia. About 150,000 bushels of these oysters are annually marketed at Washington, D. C., but the majority are sold at Baltimore. From this river come the famous "Kettle Bottoms," the largest oysters produced in Maryland.

"*Bay-shore grounds.*"—The Bay-shore grounds are situated on each side of the Chesapeake Bay outside of the tributaries previously mentioned, and extend from Pool Island to the Potomac River on the Western Shore, and from Worton Point to Smith Island on the Eastern Shore. The reefs are found in all depths of water up to 45 feet, and are almost continuous along the shore, excepting in the northern portion of the bay, and in some places are 1½ miles in width. The total area of these reefs approximates 116 square miles, of which 14 are situated within the county limits of Anne Arundel, which, together with 23 square miles located about Tally Point, Sandy Point, Hackett Point, Thomas Point, Holland Island Bar, Swan Point Bar, Plum Point, and Poplar Island, are reserved for the tongmen, leaving 79 square miles for the use of the dredgers. The annual product from these grounds during the last five seasons has averaged about 3,025,000 bushels, valued at $1,522,000, of which about 1,850,000 bushels, valued at $940,000, were obtained by the dredgers, and 1,175,000 bushels, valued at $582,500, by the tongmen.

The oysters obtained from these reefs, particularly those caught by dredges from the Anne Arundel shore to Point Lookout, are among the finest in Maryland, and are usually sold at the highest market price, being nearly always large and fat. The product from the bay shores has fluctuated very much during the last eight years, during some seasons the quantity obtained being almost twice that of the succeeding year. This was true of the seasons 1888–89 and 1889–90, and the quantity obtained since the former season has been very light compared with the extent previously. Because of the depth of water and the extent of the area along the bay shores, the

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* The dredging license fee in Virginia is 50 cents per ton per month, but vessels in that State usually dredge only about two months each season.

THE OYSTER-GROUNDS.

Tidal-water areas.—By numerous acts of the general assembly the tidal-water areas of Maryland have been divided into two classes, viz, those situated within the small bays, sounds, rivers, and creeks, and known as the inshore or "county waters," and those areas located in the Chesapeake Bay and Potomac River outside of the smaller bays and rivers and designated in this report the "State waters." Of the 2,359 square miles * of tidal-water area of Maryland, 1,025 are situated within the limits of the counties, 976 in the Chesapeake Bay, and the remaining 358 square miles in the Potomac River, thus giving the "county waters" an area of 1,025 and the "State waters" 1,334 square miles.

The distinction between "county waters" and "State waters" is of much importance to those persons desirous of understanding the condition of affairs in Maryland, not only because different methods of oystering are prosecuted in each, but also because persons are not permitted to oyster in the waters of a county unless they are residents of that county, while citizens of any portion of the State may resort to the State grounds. The counties, however, have no title to the water area situated within their limits that would prevail against the State.

Tonging, dredging, and scraping constitute the various methods of catching oysters practiced in Maryland. Excepting a few reserved areas of small extent on which no form of oyster fishery is permitted, tonging is authorized under certain restrictions and regulations as to persons, times, and methods in all Maryland waters. Dredging is permitted in the "State waters" only, and the use of a few shoal reefs located therein is reserved from the dredgers for the use of the tongmen. Scraping, which is a modified form of dredging, is authorized only in portions of the waters of Somerset, Dorchester, and Talbot counties.

Thus, of the 1,334 square miles of "State waters," 35, containing some of the best oyster reefs, are reserved for the tongmen, leaving 1,299 for the dredgers. And of the 1,025 square miles of "county waters," 748 are reserved for the tongmen and 277 may be used by both tongmen and scrapemen. While the men using tongs are permitted under certain regulations to work on all the reefs in the State, yet the other methods of catching oysters are so much more successful that in most localities the permit is scarcely a privilege, and generally tongs are used only on reefs where dredges and scrapes may not be employed.

The location of the boundary lines separating the "State waters" from the "county waters" has occupied much of the time of the general assembly and of the courts of the State. The distinction between these waters originated in an act of 1830 (L. 1829–30, ch. 87), which prohibited citizens of one county from catching oysters within 300 yards of low-water mark of either shore of any river or bay situated within the limits of another county. The original distinction has been repeatedly modified and amended since then, both by general and local enactments, but it would require too much space to give here a history of the location of these boundaries, and the accompanying chart fully indicates them as they exist at present.

The following table exhibits in detail the tidal-water area of the State and the area on which each form of fishery may be prosecuted, the unit of measurement being the square statute mile. As tonging is authorized in all waters of the State, only such areas are given under that caption as are exclusively reserved for that form of fishery. For purposes of comparison the land area of each of the 14 tide-water counties is noted in the last column.

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* All miles referred to in this report are statute miles unless otherwise indicated.

Tidal-water area of Maryland and area on which each form of fishery is authorized.

Localities.	Tonging.	Scraping.	Dredging.	Total.	Land area.
County waters.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
Somerset	71	112	....	183	365
Wicomico	19	....	....	19	369
Dorchester	89	118	....	207	610
Talbot*	73	47	....	120	285
Queen Anne	64	....	....	64	352
Kent	50	....	....	50	315
Cecil	38	....	....	38	375
Harford	35	....	....	35	422
Baltimore	46	....	....	46	650
Anne Arundel	58	....	....	58	400
Calvert	29	....	....	29	218
St. Mary	54	....	....	54	360
Charles	21	....	....	21	460
Worcester	101	....	....	101	475
Total	748	277	....	1,025	5,656
State waters.					....
Chesapeake Bay	35	....	941	976	....
Potomac River	....	....	358	358	....
Total	35	....	1,299	1,334	....
Grand total	783	277	1,299	2,359	....

* Prior to November, 1893, the scrapemen licensed to oyster in the waters of Talbot County claimed and exercised a right in common with the dredgers licensed by the State to catch oysters lying along the west side of Talbot County, between Black Walnut Point and Tilghman Point and extending to the middle of Chesapeake Bay and Eastern Bay along said line, excepting the waters in Poplar Island Narrows reserved for the tongmen. A decision of the circuit court for Anne Arundel County, made in October, 1893, restricts them, however, to the waters lying between Wade Point and Tilghman Point. An appeal has been taken to the court of appeals, in which the decision of the Anne Arundel court will be reviewed. In the above table the conditions prevailing at the present time have been considered.

Natural reefs.—In the general acceptance of the term, natural oyster-ground is a place where oysters grow without special assistance from man and in sufficiently large quantities to induce the public to resort there for a living, but not a place where oysters have not during a term of years, usually accepted as ten, occurred in sufficient quantities to make it profitable to catch them, although they may there be planted and grown. The reason for so long a period of years is that occasionally, because of the fatalities of nature or on account of overfishing, certain areas may for several years be so impoverished that they can not be profitably worked, yet after a period of time they may, by the operations of nature, recover their former productiveness.

The locations of oyster reefs are determined by physical conditions—the salinity of the water, the character of the bottom, and the food resources, all exercising important influences in qualifying a locality for the growth of these mollusks. In four-fifths of the water area of Maryland the salinity of the water and the food resources are adapted to the growth of oysters, but under natural conditions only a portion of the bottom of this area is suitable to sustain them. Hence, in this State, the condition of the bottom is a more prominent factor in determining the adaptability of a locality to the support of oyster beds than the saline constituents of the water.

The oyster reefs at present existing in Maryland occur mainly on the sides of the channels in the Chesapeake Bay as well as its tributaries, and extend usually in the direction of the current. They are in greatest abundance at the mouths of estuaries and in places where there are sudden changes in the depth of bottom, but are found in all depths of water from a few inches to 15 or more fathoms, and most plentifully where the depth is from 5 to 30 feet. The reefs extend in the Chesapeake Bay from the Virginia State line to Worton Point in Kent County, a distance of 110 miles; in the Potomac River from the mouth thereof to Maryland Point, in Charles County, a distance of 65 miles, and in the tributary bays and rivers as far up as salt water flows.

There are probably some oyster reefs in Maryland not yet known. The oystermen have no time to spend in search for them, and discoveries are made only by chance. Some of the known beds are not generally fished on, either because the oysters are too small, too much scattered, or because other and more accessible reefs produce the necessary supplies. Sometimes for a year or more a prominent reef is left almost untouched. Rarely in recent years have any of the oystermen resorted to the reefs situated about Pool Island and north of Swan Point. The large reefs lying off Smith Island and Kedges Strait were not generally worked prior to 1880. Many localities in Maryland which were formerly productive are now barren; on the contrary many places but recently barren are now producing in abundance. It was formerly stated that the Baltimore dredgers did "not know the way down the bay" in pleasantly referring to their obtaining the greater portion of their oysters above the Choptank River, while now the catch is obtained mostly from below that point.

It has been frequently stated in newspapers and other publications that the oyster beds of Maryland are practically exhausted. The product during the last few years does not indicate that this is the case, nor do the beds appear to be in extreme danger of soon becoming exhausted. It is astonishing that they have for many years yielded so abundantly and yet are in such good condition as at present. Nevertheless the reefs are undoubtedly being fished to their fullest productive capacity under present regulations, except possibly those situated in tonging areas, but too deep for utilization by those implements. Compared with the condition of thirty-five years ago the area of the reefs has been very largely increased, but because of the very vigorous fishery to which they have been subjected the size of the oysters brought to market is less and the number left on the beds at the end of each season has very materially diminished.

Occasional references are made to the former abundance of oysters around and even above Pool Island, where few are now caught, and to their occurring at the mouth of the Susquehanna River, where no oysters are now known to exist, as well as in many other places in the Chesapeake and tributaries, and their disappearance is popularly attributed to the extensive and vigorous fishery prosecuted in those waters. But the true cause for the greater part of this destruction is probably the changes in the quantity of fresh water flowing into the bay and the increased volume of the spring freshets. Forty years and more ago the farms along the tributaries of the Chesapeake were not so thoroughly cultivated as they are now, and the river and creek bottom lands were covered with timber. The more thorough cultivation of the farms, with the attendant system of ditching practiced in this section of the country and the clearing away of the timber, has caused a more rapid flow of the rain water and melted snow into the rivers and bays, which at times during the spring has freshened the water to a point beyond the endurance of the oysters. This is but one of the many adverse agencies with which oysters have to contend.

No complete survey has yet been made of the oyster reefs of the State of Maryland, in the absence of which the general understanding of the fishery can not be otherwise than imperfect and unsatisfactory, and very erroneous impressions exist as to the extent, location, and condition of these reefs. In the attempt to supply to some extent this much-needed information, the writer, with the assistance of many persons engaged in the various branches of the oyster fishery and the able coöperation of Gen. Joseph B. Seth, sometime commander of the State fishery force, has ventured to approximate the area of the reefs known at present and to map their general location, the result of this work appearing in an appended table and on the chart accompanying this report.

The total area of natural oyster-ground as developed by this review approximates 355 square miles, 144 being situated in "State waters" and 211 square miles within "county waters"; but the total area covered with compact reefs probably does not exceed 135 square miles, the remaining part being more or less covered with scattered oysters.

In 1870 Mr. Hunter Davidson, then in command of the fishery force of the State, estimated the area of the natural oyster-ground to be 373 square miles. It must not be understood, however, because the present approximation is 18 square miles less than that made 23 years ago, that a decrease in the area of the reefs has actually occurred, for the contrary is probably the case, and the apparent error is either in one of the estimates or because he adopted a different definition for natural beds than that herein accepted. Persons familiar with the difficulties encountered in the survey of natural oyster-grounds can readily understand why these estimates should differ, if the same definition of natural oyster-grounds has been accepted. It is extremely difficult and almost impracticable to determine definitely and with accuracy the outlines and limits of the beds when the oysters are much scattered, as they frequently are on the outside borders of the bed, and arbitrary limits must be adopted. Should two thoroughly impartial and careful surveys be made, with suitable instruments, but a year apart, it is quite possible and even probable that a greater discrepancy would exist between them than is found in the present instance.

The Maryland oyster commission of 1884 approximated the area of the natural oyster-grounds at 193 square miles, not including the area situated within the Potomac River. But in their approximation the area in the Pocomoke and Tangier sound regions was estimated at 28 square miles, notwithstanding the fact that a careful survey of those grounds made in 1878 and 1879 by the U. S. Coast and Geodetic Survey disclosed the area to be at least 85 square (statute) miles. If this change be made in the figures for the Tangier and Pocomoke regions and the area of the beds in the Potomac River be added, it will give, according to the estimates of the Maryland commission, nearly 300 square miles as the area of the natural oyster-grounds of the State.

The following table exhibits in detail, according to the present approximation, the area in square miles of the natural oyster-ground and the area in which each form of fishery may be prosecuted. As tonging is authorized on all the natural reefs in the State, only such area is here presented under that caption as is exclusively reserved for that form of fishery. The percentage of natural beds in both the tonging and dredging areas is very much reduced by there being several hundred square miles of area in each in which the salinity of the water is not adapted to the growth of oysters. As scraping is authorized only in three of the most productive estuaries, the percentage is naturally much higher than where the other forms of fishery are prosecuted.

Anne Arundel counties, but numbers of them are yet employed in Calvert, St. Mary, and Somerset counties.

In 1890 (ch. 333) an act local to Talbot, Queen Anne, and Kent counties was passed, providing that in those counties each man engaged in tonging or culling should be licensed, and not the boat, as was formerly the case, the fee being placed at $4 per man. The licensing of the tongmen instead of the boats had been practiced in Worcester County since 1874. This method worked so well in the three counties named, both in increasing the revenue and in enforcing the regulations of the fishery, that in 1892 (ch. 278) it was applied to all the counties of the State except Worcester, which retained its local license system of 1874.

The new license fee was placed at $3.50 for each person engaged either in tonging or culling, of which 50 cents should go to the clerk of the circuit court by whom the license was issued, 30 cents to the oyster fund of the State, and the remaining $2.70 to the public schools of the county in which the license was granted; provided that boys under 15 years of age should not be required to obtain license, and that the county commissioners of any county should be authorized to give special permission to any women who have no visible means of support to take and catch oysters without further license. It must not be understood from the last-mentioned provision that a large number of women engage in tonging oysters in Maryland. On the contrary, there are not more than two or three in the entire State, and no special demand existed for this exception to the license regulations. The number of "boys under 15 years of age" employed on the tonging boats is quite large, there probably being an average of one to every six men. The boys cull the oysters as they are tonged; this work is quite light and easily performed, except in cold or rough weather.

The effect in the change in the license system and rate has been to double the revenue derived therefrom, as will be observed from the following table exhibiting by counties the revenue from this source during each of the last five seasons. The full effect is observed by comparing the total revenue in 1888–89 or 1889–90 with that in 1892–93, the seasons 1890–91 and 1891–92 not presenting a proper comparison, as the new system was then operative in only three counties, viz, Talbot, Queen Anne, and Kent. This great increase in the revenue has been effected notwithstanding a decrease in the number of men engaged in this branch of the fishery.

Table exhibiting by counties the revenue received during the last five seasons from issuing tonging licenses.

Counties.	1888–89.	1889–90.	1890–91.	1891–92.	1892–93.	Total.
Somerset	$577.00	$560.00	$1,158.00	$1,140.00	$1,911.00	$5,346.50
Wicomico	1.301.00	1,360.00	1,399.00	1,530.00	2,271.50	7,861.50
Dorchester	2,835.00	3,694.00	3,306.00	2,799.00	5,596.50	18,230.50
Talbot	1,626.00	1,861.00	4,948.00	2,908.00	4,196.50	15,539.50
Queen Anne	868.00	1,129.00	4,148.00	4,256.00	3,286.50	13,687.50
Kent	941.50	1,091.00	3,076.00	3,688.00	3,593.50	12,390.00
Anne Arundel	1,926.00	1,931.00	2,140.00	1,953.00	3,895.50	11,845.50
Calvert	1,527.00	1,666.00	1,863.00	1,891.00	2,828.00	9,775.00
St. Mary	1,638.00	1,828.00	2.180.00	2,192.00	3,944.50	11,782.50
Charles	462.00	476.00	542.00	431.00	658.00	2,569.00
Worcester*	110.00	145.00	183.00	100.00	172.00	710.00
Total	13,811.50	15,741.00	24,943.00	22,888.00	32,353.50	109,737.50

*License system unaffected by the general law.

By the aforementioned act of 1892 the general close time on tonging was changed from April 21–September 1 to April 21–September 14. This increase in the length of the close season has been beneficial chiefly to the agricultural interests of the counties bordering the bay, due to the fact that an early opening of the oyster season makes it difficult to obtain laborers to assist in harvesting the farm produce. The following table exhibits in a condensed form the various general close times operative in the tonging branch of the oyster fishery since the adoption of the first one in 1874:

Years operative.	Close time.
1874–1879	May 1–Sept. 1.
1880–1885	Apr. 15–Sept. 1.
1886–1889	Apr. 24–Sept. 1.
1890–91	Apr. 21–Sept. 1.
1892–	Apr. 21–Sept. 14.

In addition to the general close seasons, certain localities have had local close times differing therefrom as follows:

Localities.	Years operative.	Close time.
Worcester County	1846–1860	Apr. 13–Sept. 1.
	1861	May 1–Sept. 1.
	1862–1871	Apr. 13–Sept. 1.
	1872–1873	June 1–Sept. 15.
	1874–1879	May 1–Oct. 1.
	1880–	May 1–Sept. 1.
Wicomico County	1872–1879	May 15–Sept. 1.
	1880–1885	May 1–Sept. 30.
	1886–	Apr. 15–Sept. 30.
Patuxent River	1870–1872	Apr. 20–Oct. 10.
Potomac River	1880–1884	Apr. 1–Aug. 31.
	1884–	Apr. 15–Aug. 31.

The present regulations respecting the licensing of tongmen are as follows:

> Any resident of this State desiring to catch or take oysters with rakes or tongs, for sale, in any of the waters of this State, shall first obtain, by application to the clerk of the circuit court for the county wherein he may reside, a license therefor, and such license shall have effect from the fifteenth day of September in any year in which it may have been obtained to the twentieth day of April, inclusive, next succeeding; provided that such license shall not authorize the taking or catching of oysters in any creek, cove, river, inlet, bay, or sound within the limits of any county other than that wherein the license shall have been granted, and that the boundaries of the counties bordering on navigable waters shall be strictly construed so as not to permit the residents of either county to take or catch oysters beyond the middle of the dividing channel; provided that nothing in this section shall be so construed as to prevent the citizens of Queen Anne and Kent counties from using the waters of the Chester River in common, or the citizens of Dorchester and Wicomico counties from using the waters of Nanticoke River in common, or the citizens of Queen Anne and Talbot counties from using the waters of Wye River and the mouth thereof in common, or the citizens of Dorchester and Talbot counties from using the waters of the Choptank River in common. Provided, however, that the county commissioners shall be authorized to give special permission to any woman who has no visible means of support to take and catch oysters without license. Provided also, that boys under fifteen years of age shall not be required to license.

Each and every license to take or catch oysters for sale, with rakes or tongs, shall state the name, age, and residence of the person to whom the same is to be granted, the number, and the county in which the same is to be used, and every applicant for such license shall pay to the clerk of the court when such license may be granted and before the issuing and delivery of the same, the sum of $3, and also the sum of 50 cents as a fee to the clerk for issuing the same. Nine-tenths of the amount received from tonging licenses shall be paid by the clerk to the school commissioners for the public schools in the respective counties where such licenses are issued; the sum received from white tongers to go to the white schools, and the sum received from the colored tongers to go to the colored schools.

Every applicant for license to take or catch oysters with rakes or tongs shall be required to make oath or affirmation before the clerk authorized to issue the same, or some justice of the peace, on whose certificate of the taking of such oath or affirmation the clerk shall issue said license, that the facts set forth in said license are strictly true; that he has been a bona-fide resident of the county for twelve months next preceding his application for said license; that he desires and intends to use said license in the county in which he resides, or the waters used in common, as hereinbefore provided in this article, and that he will comply with and obey all the laws of this State regulating the taking or catching of oysters.

The comptroller of the treasury shall cause to be printed and delivered to the clerk of the circuit courts for the several counties the requisite number of such blank licenses and take receipts for the same as for other licenses furnished; and said clerk shall, on the first Monday of March and December of each year, return to the comptroller a list and account of such licenses issued by them, and at the end of each tonging season shall return all unused licenses to him, and shall pay over to the comptroller one-tenth of the amount received by him for such licenses, which amount the said comptroller shall place to the credit of the "oyster fund;" and no license to take or catch oysters with rake or tong shall be used on any boat or vessel which is licensed to take or catch oysters with scoop, drag, dredge, or similar instrument, during the season for which such boat or vessel is licensed, and all licenses shall expire at the end of the season.

If any person shall use any canoe or boat not licensed as required by the preceding sections of this article in taking or catching oysters with rakes or tongs, he shall, upon conviction thereof before a justice of the peace for the county wherein the offense has been committed, be fined not less than $20 nor more than $100; and in case of refusing to pay the said fine, said party shall be confined in the house of correction for a period of not less than three months nor more than one year, and in any such case the boat or vessel shall be forfeited, and may be condemned, in the discretion of the judge or justice of the peace.

Making a careful calculation, it is found that the total product of the tonging branch of the common fishery since the beginning of the present century, not including the small stock used for lime or fertilizing purposes or those obtained by the citizens of other States, approximates 160,000,000 bushels, for which the tongmen have received about $47,000,000. Of this amount the estimated product since the adoption of the license system in 1865 is 100,000,000 bushels, valued at $32,000,000, leaving 60,000,000, valued at $15,000,000, as the catch from 1801 to 1864. The largest catch by means of tongs during any one season was doubtless in 1884–85, when 4,741 boats were licensed in the Chesapeake region alone, the product, according to the best estimates, amounting to about 6,500,000 bushels, valued at $2,375,000. But as the number of men oystering during that season was greater than ever before or since, the average catch per man was very much less than during some previous years.

The total revenue derived from the issuing of tonging licenses since 1865 and to the close of the fiscal year 1893 amounts to $319,175.65; of this sum $173,316.50 has been received during the last ten years and $109,737.50 during the last five years.

The following table exhibits the number of tonging licenses issued in each of the counties up to present date. It is proper to state that during certain seasons since 1876 many of the tongmen of Somerset County have refused to license. This has been due chiefly to the contention as to the right of oystering in common with the citizens of Virginia in the Pocomoke, and the Somerset tongmen, when feeling themselves especially aggrieved, have refused to pay the license fees.

Table showing the number of tonging licenses issued in Maryland during each season since 1865.

[Figures in bold-face type indicate that licenses were issued to the men, in other instances the boats were licensed.]

Years.	Somerset.	Wicomico.	Dorchester.	Talbot.	Queen Anne.	Kent.	Anne Arundel.	Calvert.	St. Mary.	Charles.	Worcester.	Total number of boats.	Total number of men.
1865-66......	267	89	243	212	116	117	162	139	229	19	65	1,658	....
1866-67......	263	86	251	234	103	98	193	157	220	15	64	1,684	....
1867-68......	234	92	220	241	146	84	218	183	284	21	80	1,803	....
1868-69......	246	110	257	246	105	93	222	189	336	22	81	1,907	....
1869-70......	128	115	210	202	67	77	223	180	309	16	120	1,647	....
1870-71......	178	112	331	190	115	103	234	145	267	8	(*)	1,692	....
1871-72......	252	106	441	184	119	96	240	146	220	12	(*)	1,816	....
1872-73......	245	195	575	274	178	95	300	324	362	48	(*)	2,506	....
1873-74......	125	125	405	280	183	109	421	380	307	22	(*)	2,357	....
1874-75......	329	172	472	294	210	120	314	237	325	50	**291**	2,523	**291**
1875-76......	239	98	280	276	172	101	396	207	272	49	**241**	2,090	**241**
1876-77......	72	88	212	254	146	101	250	186	244	28	**198**	1,581	**198**
1877-78......	59	133	182	217	139	106	348	198	197	23	**170**	1,602	**170**
1878-79......	2	108	142	258	144	122	343	243	212	30	**211**	1,604	**211**
1879-80......	2	134	199	281	145	123	301	312	183	41	**106**	1,721	**106**
1880-81......	37	173	291	386	391	137	310	306	297	101	**237**	2,429	**237**
1881-82......	17	171	317	371	389	114	342	314	350	118	**360**	2,503	**360**
1882-83......	25	197	353	294	511	138	364	269	386	93	**333**	2,630	**333**
1883-84......	106	183	387	260	501	181	358	259	366	180	**336**	2,781	**336**
1884-85......	756	296	696	457	648	250	407	392	663	176	**153**	4,741	**153**
1885-86......	536	300	736	453	263	267	456	367	618	136	**62**	4,132	**62**
1886-87......	317	344	742	430	248	245	472	317	610	130	**97**	3,855	**97**
1887-88......	207	340	839	450	251	262	512	359	582	112	**126**	3,914	**126**
1888-89......	191	289	861	490	284	267	560	423	558	132	**110**	4,055	**110**
1889-90......	176	297	948	559	364	316	607	461	626	136	**145**	4,490	**145**
1890-91......	355	304	1,003	**1,287**	**1,112**	**769**	650	521	757	155	**188**	3,745	**3,301**
1891-92......	330	333	933	727	**1,064**	**862**	615	531	759	122	**100**	3,623	**2,758**
1892-93......	**546**	**649**	**1,599**	**1,199**	**939**	741	**1,118**	808	**1,127**	188	**172**	....	**9,081**

*Tongmen exempt from license system.

Area and location of grounds.—The water area within the county limits of Maryland approximates 1,025 square miles. Tonging is permitted on all of this area except certain small places reserved for private use, yet as scraping is authorized in Somerset, Dorchester, and Talbot counties on 112, 118, and 47 square miles, respectively, and as the tongmen do not usually work on grounds frequented by men using more effective apparatus, only 748 square miles of water area are devoted exclusively to their use. Of this the area more or less covered with natural oyster reefs approximates 131 square miles. Of the 1,334 square miles of "State grounds," 35 square miles containing some of the best reefs are reserved for the tongmen, 23 miles of this area being covered with natural reefs. This gives a total of 154 square miles of oyster beds on which tonging alone is authorized. The average annual product from this area during the last five seasons has approximated 4,850,000 bushels, for which the oystermen have received $2,200,000, an average of 31,493 bushels and $14,269 to the square mile.

The reefs situated within the tonging areas are usually smaller in extent and not so continuous as those in the dredging and scraping areas. The ground is not so level, the oysters occurring more in heaps. These reefs are located principally along the Anne Arundel shore, in the Patuxent River, Chester River, Eastern Bay, and the small tributary waters of Choptank River and Tangier Sound. They are all close in shore where the water is shallow, usually not exceeding 26 feet in depth, and averaging from 10 to 22 feet. In a few localities, however, as in the Patuxent River, much greater depths are found; but in those places a form of tongs suitable for deep water is employed to some extent.

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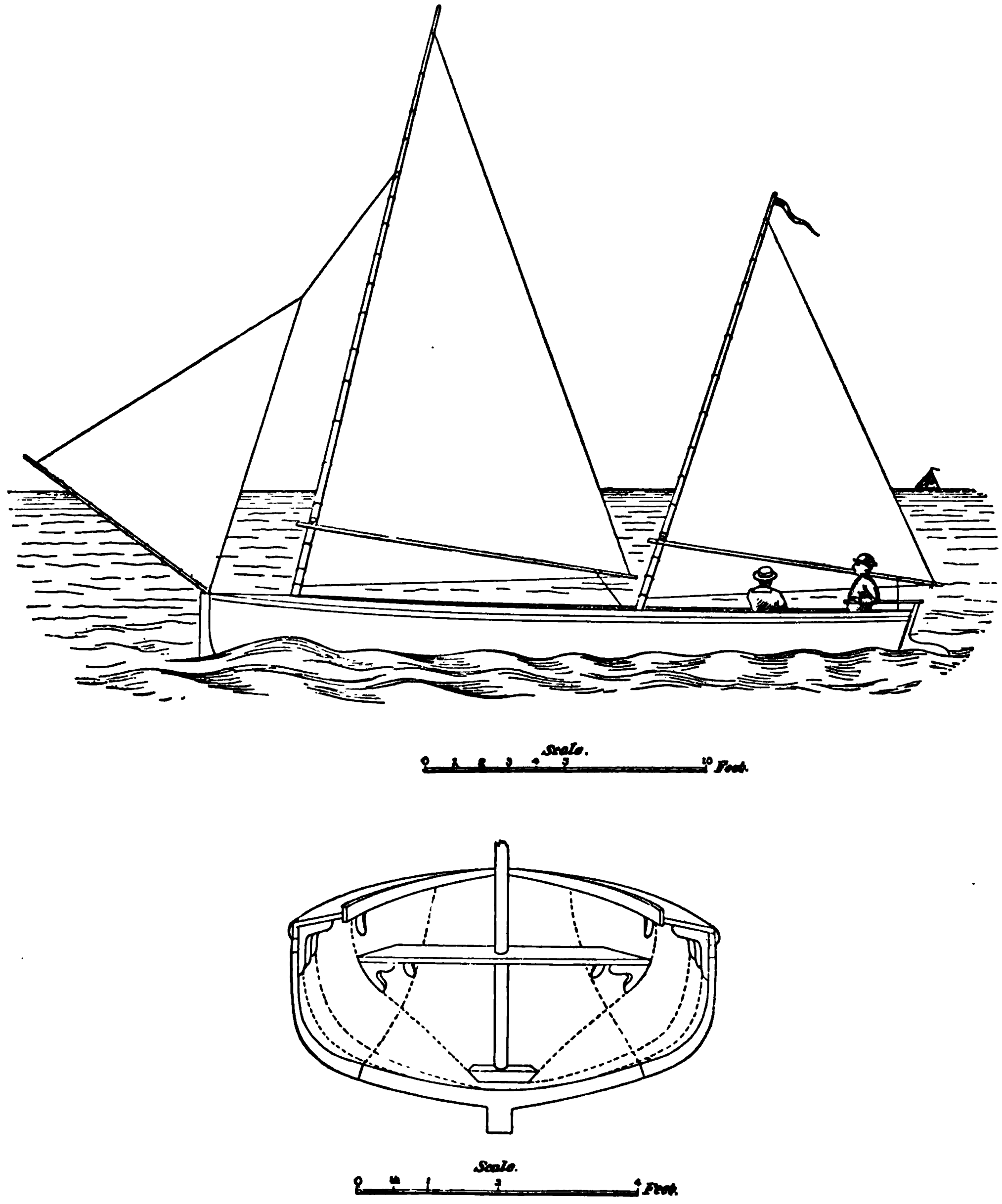


CHESAPEAKE BAY CANOE.

As the tonging reefs are situated in the inshore waters, where the dredging vessels harbor at night, and in the mouths of rivers and inlets directly in the path of navigation, the opportunities for dredging thereon without detection are great. On account of the exposed position of the dredging-grounds, situated in the deep waters off shore, the rough weather prevalent during the latter half of the oyster season prevents the dredging vessels from working more than three or four days in the week, and when not able to dredge they seek shelter in the coves and rivers with every temptation to take the oysters directly under them, resulting in the tonging reefs being not entirely free from their depredations. And at times, during periods of scarcity on the "State grounds," certain "county grounds" have been openly and defiantly used by the dredgers, this being particularly noticeable in 1888 and 1889. However, these occurrences are not so common as is generally supposed, and during the last three or four years the quantity of oysters taken in this manner has probably not been very large. It is proper to state that Maryland's experience with the difficulties encountered in protecting reserved areas has not been peculiar, nearly all the extensive oyster-producing localities having suffered in this respect.

Boats and apparatus.—Tonging is prosecuted with many forms of boats varying in size from 45 feet in length to such as are scarcely sufficient to float one man with a few bushels of oysters. The principal forms of craft employed are canoes, skiffs, bateaux, brogans, and sloops. These are built mostly on the shores of the Chesapeake and tributaries, the greater number being constructed by the oystermen who use them. Canoes are by far the most plentiful, and in some parts of Maryland the words canoe and tonging boat are synonymous. In the early part of the present century, because of the cheapness of its manufacture, this was almost the only type of boat employed by the people of Maryland in the oyster industry; and they had been in extensive use by the Indians before the settlement of the State. In reference to the canoes observed on the occasion of his visit to the Chesapeake Bay in 1609, John Smith says, in his well-known "Travels and Adventures":

> Their fishing is much in Boats. These they make of one tree, by burning and scratching away the coales with stones and shels till they have it in forme of a Trough. Some of them are an eln deep and fortie or fiftie foot in length, and some will beare 40 men, but the most ordinary are smaller, and will beare 10, 20, or 30, according to their bignesse. Instead of Oares, they use Paddles and sticks, with which they will row faster than our Barges.

Canoes were originally made of pitch pine from a single log and were straight in the bow and pointed at both ends. The average size at present is about 20 feet in length, 4 feet wide across the gunwales, and 18 inches deep on the inside. Formerly large ones, 30 feet and more in length and 5 or 6 feet wide, were also made from one log. But as the number of large pitch-pine trees decreased, the size of the canoes was necessarily lessened. This finally led to the use of three, five, and seven logs in one boat, the different logs being joined to each other by wooden keys or iron bolts driven in edgewise. When three logs are used one forms the keel and the others form the sides. The large canoes generally have a short length of decking in the bow and sometimes a small house and usually a centerboard. The smaller ones carry only one mast with a triangular sail; the larger ones have two masts with triangular sails and sometimes a jib. The cost of these canoes ranges from $60 to $600 each. Some of them last a very great length of time. The *Martha Washington*, 10.84 tons, was built in 1827 and is still doing service. The dimensions of this vessel are: length, 39 feet; breadth, 13.5 feet; depth, 4.8 feet. The number of skiffs, bateaux, brogans, and sloops employed in tonging is not large; and as these boats are not peculiar to the oyster industry of the Chesapeake, but are of the same type as employed in the fisheries of other localities, a description of them is unnecessary in this connection.

The average number of vessels and boats employed in tonging during the last five seasons has been about 5,000, with a total valuation of $410,000. Of these, 60, valued at $30,000, measure over 5 tons. Generally the tonging boats are owned by the men using them; but in some instances a large number are owned by oyster marketmen and others who hire them at so much per day to the fishermen. The license system of 1892 has had a beneficial effect in encouraging the tongmen to own their boats. The oyster regulations do not authorize the issuing of tonging licenses to those boats having a scraping or dredging license.

The tongs used in Maryland are probably larger than those employed elsewhere in America, excepting in the adjoining State, Virginia. They have from ten to eighteen teeth on each side and the shafts are from 12 to 28 feet in length. The large ones are sometimes improperly designated "rakes." The tongs hold from one-half peck to three-fourths of a bushel of material, but as a large quantity of the rubbish of the oyster beds is also taken up at the same time, the number of oysters obtained at each lift is usually very much smaller.

In the limits of Somerset, Calvert, and St. Mary counties, and along the bay shores, a number of "deep-water tongs" are employed. These have no shafts, but are much like two dredges joined together as shaft tongs are. They are hauled by ropes, the labor being generally lightened by the use of a small winder attached to the mast. These implements have been employed to a large extent only about eight years.

The tongmen.—The crew of a boat engaged in tonging consists of from one to three persons, one of whom is frequently a boy, whose duty it is to attend to the culling, throwing the shells and small oysters back into the water. The total number of persons employed in this branch of the oyster fishery during the last five years has averaged about 11,000, of whom about 1,500 were boys. Usually the men in one boat work on shares, while the boys are employed on wages varying from 50 cents to $1.25 per day. One effect of the present or "1892 license regulation" has been to decrease the average number of persons tonging from one boat and to increase the number of boys employed in the fishery.

The tongmen live near the shores adjacent to the reefs and are all citizens of Maryland, non-residents not being permitted to engage in this branch of the fishery. They are also mostly natives of the State, there probably not being 100 tongmen in the whole State not born and raised there, and about one-fourth of them are colored. All are not entirely dependent on oystering for support, the greater number engaging also in agricultural pursuits, while many of the remaining find occasional employment in the various industries of the bay counties. Most of them own small homes and an acre or so of ground, which constitutes a garden.

There are few workmen in America more independent than these. At almost any time during the season a tongman can in a good working day catch from 4 to 12 bushels of oysters, for which there is always a demand almost at his door. Then having sufficient to supply his temporary needs he usually takes things easy. While some are indolent and work only when compelled by necessity, yet as a class they compare favorably in industry and morals with any other body of men similarly situated.

The annual incomes of the tongmen range from $100 to $800, averaging about

$225. They sell their catch to the neighboring market-houses or to the transportation vessels. Usually the men engaging in this fishery do not work therein more than about 125 or 140 days during the season, the rough weather interfering with their operations during the rest of the time. During September, October, and November, which are particularly pleasant months on the Chesapeake, they average about 20 days each month; but in January and February they work only about 5 to 15 days each, and occasionally during those two months they are compelled to remain ashore for weeks at a time.

DREDGING.

Historical notes.—The use of dredges in the oyster fishery of Maryland originated about the beginning of the present century. In the early history of the industry the small quantity of oysters required to supply local markets did not warrant the purchase of these implements, but as the demand increased the more efficient apparatus was brought into use, and dredges were soon employed in all the waters of the State in which oysters were obtained in large quantities for commercial purposes, this being confined mostly to the lower portions of the bay. But their use had long been regarded as destructive to the reefs, and the opposition to them dated from their introduction into these waters.

The first oyster law of Maryland (L. 1820–21, ch. 24), passed December 22, 1820, was enacted to prohibit their employment in any part of the State, this enactment being preceded by the preamble given on page 209, which sets forth the reasons for adopting this extreme protective measure. This regulation, however, on account of the extensive area of water to be protected, could not be fully enforced. In the attempt to enforce compliance with its provisions each tide-water county took the matter in hand, and the sheriffs with their deputies and the posse comitatus frequently sallied forth, impressing sail and steam vessels into their service to arrest the offenders, but without accomplishing the desired result. The law, however, was frequently reënacted or amended with increased or more easily applied penalties, and from 1820 to 1865 the use of any form of dredges in catching oysters in Maryland waters was unlawful, except as affected by a local regulation enacted in 1854 authorizing the use of scrapes in the waters of Somerset County by the citizens thereof.

The difficulty experienced in wholly preventing this mode of oystering and the doubt entertained by many persons as to the good policy and utility of such a procedure, together with the need of revenue in the State treasury, led to the compromise of 1865 and the adoption of the license system.

This system provided in reference to dredging as follows: The comptroller of the State treasury was required to issue a license to any applicant who had been for the twelve months immediately preceding a resident of the State, said license authorizing him to use a vessel owned by him in catching oysters by means of dredges from September 1 to June 1 following, in each year, "within the waters of the Chesapeake Bay, and not within any other bay, river, creek, strait, or sound, and not on any oyster bed or rock on or about Tally Point, Sandy Point, Hackett Point, Thomas Point, or Three Sisters, on the western side of the Chesapeake Bay, and not within the Chesapeake Bay where the water is less than 15 feet deep." The fee for the license was placed at $5 per ton; the license to be renewed annually. Steam was not permitted to be used in any manner in the catching of oysters, and all licensed vessels even when a boat was apprehended on interdicted areas with wet oysters, that the same were not obtained by means of tongs.

By act of 1872 (ch. 241) it was made unlawful for any person to remove oysters from the limits of Wicomico County between May 15 and September 1 of each year, and at the same session a new close season was established on the natural reefs in Worcester County, this time from June 1 to September 15 of each year, but the act requiring the tongmen in this county to obtain license was at the same time repealed. But in 1874 (ch. 77) the tongmen of Worcester were again required to obtain licenses, the rate being fixed at $3 per man, which in 1876 was reduced to $1 per man, the revenue derived therefrom to be expended by the county commissioners in the purchase of seed oysters to be planted in the waters of that county. This act also changed the close season on the natural reefs in Worcester from June 1–September 15 to May 1–October 1 of each year; but this was again changed in 1880 to May 1–September 1, this being the present close season operative in that county.

By act of 1874 (ch. 181) persons were prohibited from tonging oysters except for private use, or for the purpose of replanting or bedding in the State, or for sale to citizens of the county wherein they are caught or of the county next adjoining, between May 1 and September 1 in each year, this being the first attempt at establishing a general close time on this branch of the industry. This act also required that all fees derived from issuing tonging licenses, except in Worcester County, should be devoted to the public schools of the respective counties wherein the licenses were issued, the sum received from white owners of licensed boats going to the support of the white schools and the sum from the colored owners to the colored schools.

In 1880 (ch. 198) the general close time was increased fifteen days, being changed to April 15–September 1. As the close time established in 1874 did not interdict the taking of oysters for sale in the county where caught or in the adjoining county, the close time provided for in 1880 was practically the first general one operative on the tonging branch of the fishery. But this act permitted the taking of oysters during the interdicted time in quantities not exceeding 5 bushels per day for private use or for planting purposes, and when the courts were called upon to interpret this provision they rendered decisions permitting the taking of unlimited quantities, so that the provision was effective only during a portion of one season. The proper remedy, however, was applied at the next session of the general assembly, and in 1886 (ch. 296) the length of the general close time was decreased for the first time since the adoption of the system, being changed from April 15–September 1 to April 24–September 1.

Before the enforcement of the general close season on tonging, the men engaged in this fishery had a great advantage in the privilege to catch and bed oysters during the summer months and thus have a supply on hand for the winter markets. This privilege, however, was little appreciated and few persons took advantage of it.

About this time there was introduced in Maryland an apparatus for catching oysters, commonly called "deep-water tongs," of which there are a number of varieties. They all differ from the ordinary tongs in being much larger and heavier and have no shafts, being lifted by means of ropes and winders. They are much more injurious to the reefs than the ordinary tongs, but are employed with much success in places having too great a depth of water to permit the use of shaft tongs, the latter being the more effective implements in depths less than 24 feet. In 1888 (ch. 394) the use of these implements was prohibited in the waters of Talbot, Queen Anne, Dorchester, and

Anne Arundel counties, but numbers of them are yet employed in Calvert, St. Mary, and Somerset counties.

In 1890 (ch. 333) an act local to Talbot, Queen Anne, and Kent counties was passed, providing that in those counties each man engaged in tonging or culling should be licensed, and not the boat, as was formerly the case, the fee being placed at $4 per man. The licensing of the tongmen instead of the boats had been practiced in Worcester County since 1874. This method worked so well in the three counties named, both in increasing the revenue and in enforcing the regulations of the fishery, that in 1892 (ch. 278) it was applied to all the counties of the State except Worcester, which retained its local license system of 1874.

The new license fee was placed at $3.50 for each person engaged either in tonging or culling, of which 50 cents should go to the clerk of the circuit court by whom the license was issued, 30 cents to the oyster fund of the State, and the remaining $2.70 to the public schools of the county in which the license was granted; provided that boys under 15 years of age should not be required to obtain license, and that the county commissioners of any county should be authorized to give special permission to any women who have no visible means of support to take and catch oysters without further license. It must not be understood from the last-mentioned provision that a large number of women engage in tonging oysters in Maryland. On the contrary, there are not more than two or three in the entire State, and no special demand existed for this exception to the license regulations. The number of "boys under 15 years of age" employed on the tonging boats is quite large, there probably being an average of one to every six men. The boys cull the oysters as they are tonged; this work is quite light and easily performed, except in cold or rough weather.

The effect in the change in the license system and rate has been to double the revenue derived therefrom, as will be observed from the following table exhibiting by counties the revenue from this source during each of the last five seasons. The full effect is observed by comparing the total revenue in 1888–89 or 1889–90 with that in 1892–93, the seasons 1890–91 and 1891–92 not presenting a proper comparison, as the new system was then operative in only three counties, viz, Talbot, Queen Anne, and Kent. This great increase in the revenue has been effected notwithstanding a decrease in the number of men engaged in this branch of the fishery.

Table exhibiting by counties the revenue received during the last five seasons from issuing tonging licenses.

Counties.	1888–89.	1889–90.	1890–91.	1891–92.	1892–93.	Total.
Somerset	$577.00	$560.00	$1,158.00	$1,140.00	$1,911.00	$5,346.50
Wicomico	1.301.00	1,360.00	1,399.00	1,530.00	2,271.50	7,861.50
Dorchester	2,835.00	3,694.00	3,306.00	2,799.00	5.596.50	18,230.50
Talbot	1,626.00	1,861.00	4,948.00	2,908.00	4,196.50	15,539.50
Queen Anne	868.00	1,129.00	4,148.00	4,256.00	3,286.50	13,687.50
Kent	941.50	1,091.00	3,076.00	3,688.00	3,593.50	12,390.00
Anne Arundel	1,926.00	1,931.00	2,140.00	1,953.00	3,895.50	11,845.50
Calvert	1,527.00	1,666.00	1,863.00	1,891.00	2,828.00	9,775.00
St. Mary	1,638.00	1,828.00	2.180.00	2,192.00	3,944.50	11,782.50
Charles	462.00	476.00	542.00	431.00	658.00	2,569.00
Worcester*	110.00	145.00	183.00	100.00	172.00	710.00
Total	13,811.50	15,741.00	24,943.00	22,888.00	32,353.50	109,737.50

*License system unaffected by the general law.

By the aforementioned act of 1892 the general close time on tonging was changed from April 21–September 1 to April 21–September 14. This increase in the length of the close season has been beneficial chiefly to the agricultural interests of the counties bordering the bay, due to the fact that an early opening of the oyster season makes it difficult to obtain laborers to assist in harvesting the farm produce. The following table exhibits in a condensed form the various general close times operative in the tonging branch of the oyster fishery since the adoption of the first one in 1874:

Years operative.	Close time.
1874–1879	May 1–Sept. 1.
1880–1885	Apr. 15–Sept. 1.
1886–1889	Apr. 24–Sept. 1.
1890–91	Apr. 21–Sept. 1.
1892–	Apr. 21–Sept. 14.

In addition to the general close seasons, certain localities have had local close times differing therefrom as follows:

Localities.	Years operative.	Close time.
Worcester County	1846–1860	Apr. 13–Sept. 1.
	1861	May 1–Sept. 1.
	1862–1871	Apr. 13–Sept. 1.
	1872–1873	June 1–Sept. 15.
	1874–1879	May 1–Oct. 1.
	1880–	May 1–Sept. 1.
Wicomico County	1872–1879	May 15–Sept. 1.
	1880–1885	May 1–Sept. 30.
	1886–	Apr. 15–Sept. 30.
Patuxent River	1870–1872	Apr. 20–Oct. 10.
Potomac River	1880–1884	Apr. 1–Aug. 31.
	1884–	Apr. 15–Aug. 31.

The present regulations respecting the licensing of tongmen are as follows:

> Any resident of this State desiring to catch or take oysters with rakes or tongs, for sale, in any of the waters of this State, shall first obtain, by application to the clerk of the circuit court for the county wherein he may reside, a license therefor, and such license shall have effect from the fifteenth day of September in any year in which it may have been obtained to the twentieth day of April, inclusive, next succeeding; provided that such license shall not authorize the taking or catching of oysters in any creek, cove, river, inlet, bay, or sound within the limits of any county other than that wherein the license shall have been granted, and that the boundaries of the counties bordering on navigable waters shall be strictly construed so as not to permit the residents of either county to take or catch oysters beyond the middle of the dividing channel; provided that nothing in this section shall be so construed as to prevent the citizens of Queen Anne and Kent counties from using the waters of the Chester River in common, or the citizens of Dorchester and Wicomico counties from using the waters of Nanticoke River in common, or the citizens of Queen Anne and Talbot counties from using the waters of Wye River and the mouth thereof in common, or the citizens of Dorchester and Talbot counties from using the waters of the Choptank River in common. Provided, however, that the county commissioners shall be authorized to give special permission to any woman who has no visible means of support to take and catch oysters without license. Provided also, that boys under fifteen years of age shall not be required to license.

Each and every license to take or catch oysters for sale, with rakes or tongs, shall state the name, age, and residence of the person to whom the same is to be granted, the number, and the county in which the same is to be used, and every applicant for such license shall pay to the clerk of the court when such license may be granted and before the issuing and delivery of the same, the sum of $3, and also the sum of 50 cents as a fee to the clerk for issuing the same. Nine-tenths of the amount received from tonging licenses shall be paid by the clerk to the school commissioners for the public schools in the respective counties where such licenses are issued; the sum received from white tongers to go to the white schools, and the sum received from the colored tongers to go to the colored schools.

Every applicant for license to take or catch oysters with rakes or tongs shall be required to make oath or affirmation before the clerk authorized to issue the same, or some justice of the peace, on whose certificate of the taking of such oath or affirmation the clerk shall issue said license, that the facts set forth in said license are strictly true; that he has been a bona-fide resident of the county for twelve months next preceding his application for said license; that he desires and intends to use said license in the county in which he resides, or the waters used in common, as hereinbefore provided in this article, and that he will comply with and obey all the laws of this State regulating the taking or catching of oysters.

The comptroller of the treasury shall cause to be printed and delivered to the clerk of the circuit courts for the several counties the requisite number of such blank licenses and take receipts for the same as for other licenses furnished; and said clerk shall, on the first Monday of March and December of each year, return to the comptroller a list and account of such licenses issued by them, and at the end of each tonging season shall return all unused licenses to him, and shall pay over to the comptroller one-tenth of the amount received by him for such licenses, which amount the said comptroller shall place to the credit of the "oyster fund;" and no license to take or catch oysters with rake or tong shall be used on any boat or vessel which is licensed to take or catch oysters with scoop, drag, dredge, or similar instrument, during the season for which such boat or vessel is licensed, and all licenses shall expire at the end of the season.

If any person shall use any canoe or boat not licensed as required by the preceding sections of this article in taking or catching oysters with rakes or tongs, he shall, upon conviction thereof before a justice of the peace for the county wherein the offense has been committed, be fined not less than $20 nor more than $100; and in case of refusing to pay the said fine, said party shall be confined in the house of correction for a period of not less than three months nor more than one year, and in any such case the boat or vessel shall be forfeited, and may be condemned, in the discretion of the judge or justice of the peace.

Making a careful calculation, it is found that the total product of the tonging branch of the common fishery since the beginning of the present century, not including the small stock used for lime or fertilizing purposes or those obtained by the citizens of other States, approximates 160,000,000 bushels, for which the tongmen have received about $47,000,000. Of this amount the estimated product since the adoption of the license system in 1865 is 100,000,000 bushels, valued at $32,000,000, leaving 60,000,000, valued at $15,000,000, as the catch from 1801 to 1864. The largest catch by means of tongs during any one season was doubtless in 1884–85, when 4,741 boats were licensed in the Chesapeake region alone, the product, according to the best estimates, amounting to about 6,500,000 bushels, valued at $2,375,000. But as the number of men oystering during that season was greater than ever before or since, the average catch per man was very much less than during some previous years.

The total revenue derived from the issuing of tonging licenses since 1865 and to the close of the fiscal year 1893 amounts to $319,175.65; of this sum $173,316.50 has been received during the last ten years and $109,737.50 during the last five years.

The following table exhibits the number of tonging licenses issued in each of the counties up to present date. It is proper to state that during certain seasons since 1876 many of the tongmen of Somerset County have refused to license. This has been due chiefly to the contention as to the right of oystering in common with the citizens of Virginia in the Pocomoke, and the Somerset tongmen, when feeling themselves especially aggrieved, have refused to pay the license fees.

Table showing the number of tonging licenses issued in Maryland during each season since 1865.

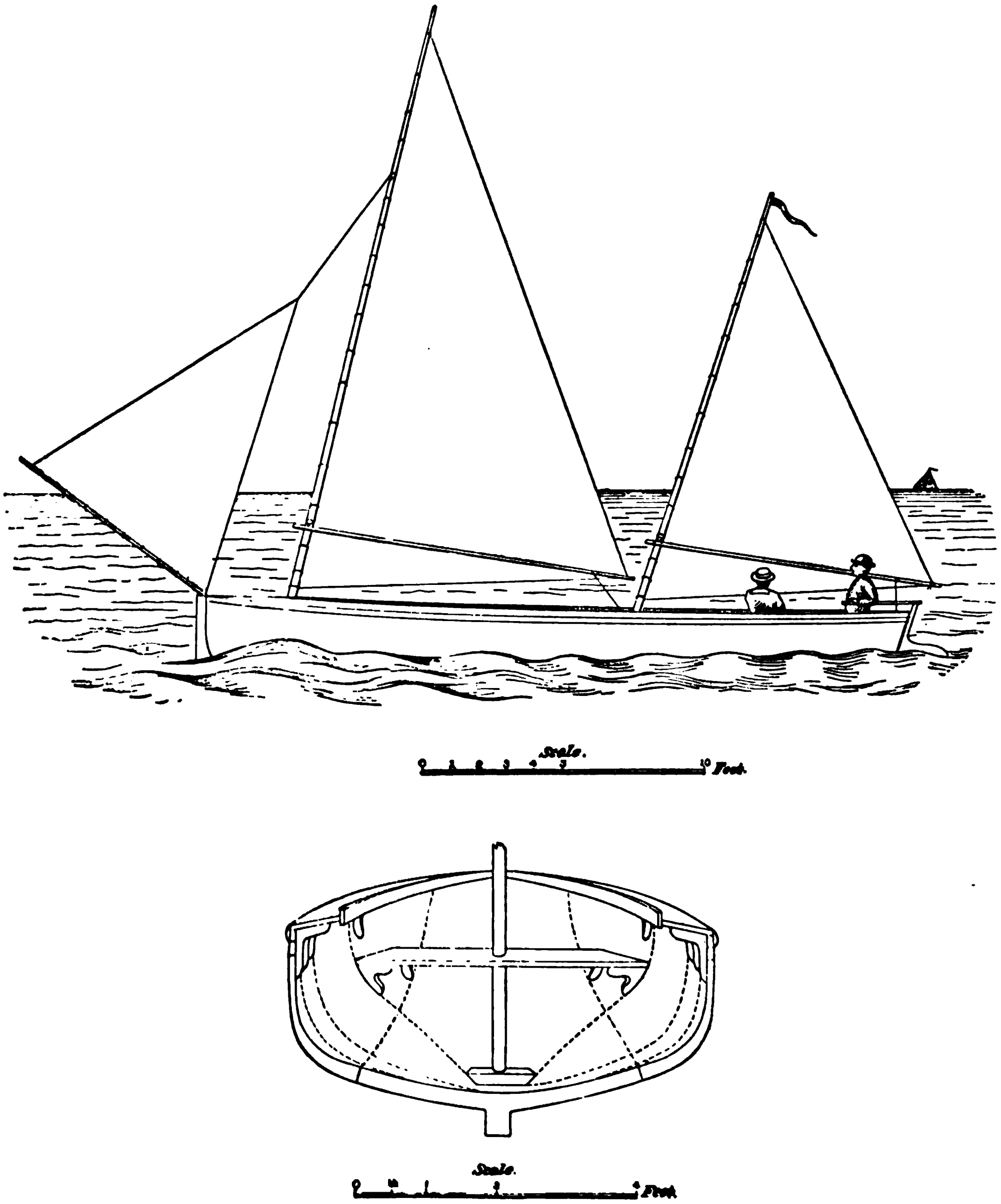
[Figures in bold-face type indicate that licenses were issued to the men, in other instances the boats were licensed.]

Years.	Somerset.	Wicomico.	Dorchester.	Talbot.	Queen Anne.	Kent.	Anne Arundel.	Calvert.	St. Mary.	Charles.	Worcester.	Total number of boats.	Total number of men.
1865-66	267	89	243	212	116	117	162	139	229	19	65	1,658	....
1866-67	263	86	251	234	103	98	193	157	220	15	64	1,684	....
1867-68	234	92	220	241	146	84	218	183	284	21	80	1,803	....
1868-69	246	110	257	246	105	93	222	189	336	22	81	1,907	....
1869-70	128	115	210	202	67	77	223	180	309	16	120	1,647	....
1870-71	178	112	331	199	115	103	234	145	267	8	(*)	1,692	....
1871-72	252	106	441	184	119	96	240	146	220	12	(*)	1,816	....
1872-73	245	195	575	274	178	95	300	324	362	48	(*)	2,596	....
1873-74	125	126	405	280	183	109	421	380	307	22	(*)	2,357	....
1874-75	329	172	472	294	210	120	314	237	325	50	**291**	2,523	**291**
1875-76	239	98	280	276	172	101	396	207	272	49	**241**	2,090	**241**
1876-77	72	88	212	254	146	101	250	186	244	28	**198**	1,581	**198**
1877-78	59	133	182	217	139	106	348	198	197	23	**170**	1,602	**170**
1878-79	2	108	142	258	144	122	343	243	212	30	**211**	1,604	**211**
1879-80	2	134	199	281	145	123	301	312	183	41	**106**	1,721	**106**
1880-81	37	173	291	386	391	137	310	306	297	101	**237**	2,429	**237**
1881-82	17	171	317	371	389	114	342	314	350	118	**360**	2,503	**360**
1882-83	25	197	353	294	511	138	364	269	386	93	**333**	2,630	**333**
1883-84	106	183	387	260	501	181	358	259	366	180	**336**	2,781	**336**
1884-85	756	296	696	457	648	250	407	392	663	176	**153**	4,741	**153**
1885-86	536	300	736	453	263	267	456	367	618	136	**62**	4,132	**62**
1886-87	317	344	742	430	248	245	472	317	610	130	**97**	3,855	**97**
1887-88	207	340	839	450	251	262	512	359	582	112	**126**	3,914	**126**
1888-89	191	289	861	490	284	267	560	423	558	132	**110**	4,055	**110**
1889-90	176	297	948	559	364	316	607	461	626	136	**145**	4,490	**145**
1890-91	355	304	1,003	**1,287**	**1,112**	**769**	650	521	757	155	**183**	3,745	**3,801**
1891-92	330	333	933	**727**	**1,064**	**862**	615	531	759	122	**100**	3,623	**2,753**
1892-93	**546**	**649**	**1,599**	**1,199**	**939**	**741**	**1,113**	**808**	**1,127**	**188**	**172**	....	**9,081**

*Tongmen exempt from license system.

Area and location of grounds.—The water area within the county limits of Maryland approximates 1,025 square miles. Tonging is permitted on all of this area except certain small places reserved for private use, yet as scraping is authorized in Somerset, Dorchester, and Talbot counties on 112, 118, and 47 square miles, respectively, and as the tongmen do not usually work on grounds frequented by men using more effective apparatus, only 748 square miles of water area are devoted exclusively to their use. Of this the area more or less covered with natural oyster reefs approximates 131 square miles. Of the 1,334 square miles of "State grounds," 35 square miles containing some of the best reefs are reserved for the tongmen, 23 miles of this area being covered with natural reefs. This gives a total of 154 square miles of oyster beds on which tonging alone is authorized. The average annual product from this area during the last five seasons has approximated 4,850,000 bushels, for which the oystermen have received $2,200,000, an average of 31,493 bushels and $14,269 to the square mile.

The reefs situated within the tonging areas are usually smaller in extent and not so continuous as those in the dredging and scraping areas. The ground is not so level, the oysters occurring more in heaps. These reefs are located principally along the Anne Arundel shore, in the Patuxent River, Chester River, Eastern Bay, and the small tributary waters of Choptank River and Tangier Sound. They are all close in shore where the water is shallow, usually not exceeding 26 feet in depth, and averaging from 10 to 22 feet. In a few localities, however, as in the Patuxent River, much greater depths are found; but in those places a form of tongs suitable for deep water is employed to some extent.



CHESAPEAKE BAY CANOE.

As the tonging reefs are situated in the inshore waters, where the dredging vessels harbor at night, and in the mouths of rivers and inlets directly in the path of navigation, the opportunities for dredging thereon without detection are great. On account of the exposed position of the dredging-grounds, situated in the deep waters off shore, the rough weather prevalent during the latter half of the oyster season prevents the dredging vessels from working more than three or four days in the week, and when not able to dredge they seek shelter in the coves and rivers with every temptation to take the oysters directly under them, resulting in the tonging reefs being not entirely free from their depredations. And at times, during periods of scarcity on the "State grounds," certain "county grounds" have been openly and defiantly used by the dredgers, this being particularly noticeable in 1888 and 1889. However, these occurrences are not so common as is generally supposed, and during the last three or four years the quantity of oysters taken in this manner has probably not been very large. It is proper to state that Maryland's experience with the difficulties encountered in protecting reserved areas has not been peculiar, nearly all the extensive oyster-producing localities having suffered in this respect.

Boats and apparatus.—Tonging is prosecuted with many forms of boats varying in size from 45 feet in length to such as are scarcely sufficient to float one man with a few bushels of oysters. The principal forms of craft employed are canoes, skiffs, bateaux, brogans, and sloops. These are built mostly on the shores of the Chesapeake and tributaries, the greater number being constructed by the oystermen who use them. Canoes are by far the most plentiful, and in some parts of Maryland the words canoe and tonging boat are synonymous. In the early part of the present century, because of the cheapness of its manufacture, this was almost the only type of boat employed by the people of Maryland in the oyster industry; and they had been in extensive use by the Indians before the settlement of the State. In reference to the canoes observed on the occasion of his visit to the Chesapeake Bay in 1609, John Smith says, in his well-known "Travels and Adventures":

> Their fishing is much in Boats. These they make of one tree, by burning and scratching away the coales with stones and shels till they have it in forme of a Trough. Some of them are an eln deep and fortie or fiftie foot in length, and some will beare 40 men, but the most ordinary are smaller, and will beare 10, 20, or 30, according to their bignesse. Instead of Oares, they use Paddles and sticks, with which they will row faster than our Barges.

Canoes were originally made of pitch pine from a single log and were straight in the bow and pointed at both ends. The average size at present is about 20 feet in length, 4 feet wide across the gunwales, and 18 inches deep on the inside. Formerly large ones, 30 feet and more in length and 5 or 6 feet wide, were also made from one log. But as the number of large pitch-pine trees decreased, the size of the canoes was necessarily lessened. This finally led to the use of three, five, and seven logs in one boat, the different logs being joined to each other by wooden keys or iron bolts driven in edgewise. When three logs are used one forms the keel and the others form the sides. The large canoes generally have a short length of decking in the bow and sometimes a small house and usually a centerboard. The smaller ones carry only one mast with a triangular sail; the larger ones have two masts with triangular sails and sometimes a jib. The cost of these canoes ranges from $60 to $600 each. Some of them last a very great length of time. The *Martha Washington*, 10.84 tons, was built in 1827 and is still doing service. The dimensions of this vessel are: length, 39 feet; breadth, 13.5 feet; depth, 4.8 feet. The number of skiffs, bateaux, brogans, and sloops employed in tonging is not large; and as these boats are not peculiar to the oyster industry of the Chesapeake, but are of the same type as employed in the fisheries of other localities, a description of them is unnecessary in this connection.

The average number of vessels and boats employed in tonging during the last five seasons has been about 5,000, with a total valuation of $410,000. Of these, 60, valued at $30,000, measure over 5 tons. Generally the tonging boats are owned by the men using them; but in some instances a large number are owned by oyster marketmen and others who hire them at so much per day to the fishermen. The license system of 1892 has had a beneficial effect in encouraging the tongmen to own their boats. The oyster regulations do not authorize the issuing of tonging licenses to those boats having a scraping or dredging license.

The tongs used in Maryland are probably larger than those employed elsewhere in America, excepting in the adjoining State, Virginia. They have from ten to eighteen teeth on each side and the shafts are from 12 to 28 feet in length. The large ones are sometimes improperly designated "rakes." The tongs hold from one-half peck to three-fourths of a bushel of material, but as a large quantity of the rubbish of the oyster beds is also taken up at the same time, the number of oysters obtained at each lift is usually very much smaller.

In the limits of Somerset, Calvert, and St. Mary counties, and along the bay shores, a number of "deep-water tongs" are employed. These have no shafts, but are much like two dredges joined together as shaft tongs are. They are hauled by ropes, the labor being generally lightened by the use of a small winder attached to the mast. These implements have been employed to a large extent only about eight years.

The tongmen.—The crew of a boat engaged in tonging consists of from one to three persons, one of whom is frequently a boy, whose duty it is to attend to the culling, throwing the shells and small oysters back into the water. The total number of persons employed in this branch of the oyster fishery during the last five years has averaged about 11,000, of whom about 1,500 were boys. Usually the men in one boat work on shares, while the boys are employed on wages varying from 50 cents to $1.25 per day. One effect of the present or "1892 license regulation" has been to decrease the average number of persons tonging from one boat and to increase the number of boys employed in the fishery.

The tongmen live near the shores adjacent to the reefs and are all citizens of Maryland, non-residents not being permitted to engage in this branch of the fishery. They are also mostly natives of the State, there probably not being 100 tongmen in the whole State not born and raised there, and about one-fourth of them are colored. All are not entirely dependent on oystering for support, the greater number engaging also in agricultural pursuits, while many of the remaining find occasional employment in the various industries of the bay counties. Most of them own small homes and an acre or so of ground, which constitutes a garden.

There are few workmen in America more independent than these. At almost any time during the season a tongman can in a good working day catch from 4 to 12 bushels of oysters, for which there is always a demand almost at his door. Then having sufficient to supply his temporary needs he usually takes things easy. While some are indolent and work only when compelled by necessity, yet as a class they compare favorably in industry and morals with any other body of men similarly situated.

The annual incomes of the tongmen range from $100 to $800, averaging about

$225. They sell their catch to the neighboring market-houses or to the transportation vessels. Usually the men engaging in this fishery do not work therein more than about 125 or 140 days during the season, the rough weather interfering with their operations during the rest of the time. During September, October, and November, which are particularly pleasant months on the Chesapeake, they average about 20 days each month; but in January and February they work only about 5 to 15 days each, and occasionally during those two months they are compelled to remain ashore for weeks at a time.

DREDGING.

Historical notes.—The use of dredges in the oyster fishery of Maryland originated about the beginning of the present century. In the early history of the industry the small quantity of oysters required to supply local markets did not warrant the purchase of these implements, but as the demand increased the more efficient apparatus was brought into use, and dredges were soon employed in all the waters of the State in which oysters were obtained in large quantities for commercial purposes, this being confined mostly to the lower portions of the bay. But their use had long been regarded as destructive to the reefs, and the opposition to them dated from their introduction into these waters.

The first oyster law of Maryland (L. 1820–21, ch. 24), passed December 22, 1820, was enacted to prohibit their employment in any part of the State, this enactment being preceded by the preamble given on page 209, which sets forth the reasons for adopting this extreme protective measure. This regulation, however, on account of the extensive area of water to be protected, could not be fully enforced. In the attempt to enforce compliance with its provisions each tide-water county took the matter in hand, and the sheriffs with their deputies and the posse comitatus frequently sallied forth, impressing sail and steam vessels into their service to arrest the offenders, but without accomplishing the desired result. The law, however, was frequently reënacted or amended with increased or more easily applied penalties, and from 1820 to 1865 the use of any form of dredges in catching oysters in Maryland waters was unlawful, except as affected by a local regulation enacted in 1854 authorizing the use of scrapes in the waters of Somerset County by the citizens thereof.

The difficulty experienced in wholly preventing this mode of oystering and the doubt entertained by many persons as to the good policy and utility of such a procedure, together with the need of revenue in the State treasury, led to the compromise of 1865 and the adoption of the license system.

This system provided in reference to dredging as follows: The comptroller of the State treasury was required to issue a license to any applicant who had been for the twelve months immediately preceding a resident of the State, said license authorizing him to use a vessel owned by him in catching oysters by means of dredges from September 1 to June 1 following, in each year, "within the waters of the Chesapeake Bay, and not within any other bay, river, creek, strait, or sound, and not on any oyster bed or rock on or about Tally Point, Sandy Point, Hackett Point, Thomas Point, or Three Sisters, on the western side of the Chesapeake Bay, and not within the Chesapeake Bay where the water is less than 15 feet deep." The fee for the license was placed at $5 per ton; the license to be renewed annually. Steam was not permitted to be used in any manner in the catching of oysters, and all licensed vessels were required to carry printed numbers on their sails in a particular manner so that they might thereby be easily identified.

The State records show that during the first season after the adoption of this regulation, the number of dredging licenses issued was 391, the amount of license money paid for these being $43,862.40. The first license to dredge oysters issued by the State was granted on August 1, 1865, to the Baltimore schooner *Alice*, 37.41 tons measurement. According to records furnished by the late Mr. C. S. Maltby, the quantity of oysters taken by the dredging vessels amounted during that season to 3,663,125 bushels, including the catch made by the scraping vessels of Somerset County, which during that season was very small.

As the scraping regulations of Somerset County, which had then been operative eleven years, had encouraged the building of a large number of vessels suitable for using dredges, a greater number of licenses were issued to residents of that county than any other. Almost an equal number of vessels owned at Baltimore, and which had been engaged in transporting oysters and farm produce, were also licensed. The vessels from Somerset County, having been built for use in Tangier Sound, were smaller than those from Baltimore, the average tonnage from the two places being 20.10 and 25.36, respectively, and the total number of vessels licensed in those two localities 189 and 154, respectively. The number of vessels licensed in that season from the other counties was only 48, with an average tonnage of 22.34 tons, making a total of 391 vessels and 8,772.48 tons.

At the next session of the general assembly (L. 1867, ch. 184) the dredging regulations were somewhat modified, the principal changes consisting in a reduction in the license fee from $5 to $2 per ton and the adoption of other methods of enforcing the penalties for violations. By this act, in addition to the reefs mentioned in the act of 1865, the dredgers were prohibited from working on or about Holland Point bar and Plum Point; but the restriction against dredging in the Chesapeake Bay (the "State waters") where the water is less than 15 feet deep was removed.

In 1868 the license rate was again changed (L. 1868, ch. 406), this time to $3 per ton, at which it has remained to the present time. By this act, in addition to the reefs heretofore mentioned, Swan Point reefs were reserved from the dredgers.

According to estimates furnished by Mr. Hunter Davidson, the commander of the fishery force from 1868 to 1872, the quantity of oysters taken by the dredgers and scrapemen combined in 1868–69 was 6,305,600 bushels; in 1869–70, 7,190,400 bushels; in 1870–71, 6,686,400 bushels, for which the fishermen received $2,216,960, $2,516,640, and $2,240,240, respectively.

In 1870 (ch. 364) the close season on dredging was increased thirty days, being changed from June 1–August 31 to May 15–September 15; and by the act of 1874 (ch. 181) this was again increased thirty days, being placed at May 1–September 30. By the latter act the dredgers were further prohibited from working within one-fourth mile west of Poplar Island or on the valuable reefs between that island and the mainland, but as a concession the lower portion of Eastern Bay was thrown open to their use.

By act of 1880 (ch. 198) the close time on dredging was increased forty-five days, being changed to April 1–October 14, this being the close season operative at present, except that the close time in the Potomac River is from April 1 to October 31.

In 1884 (ch. 518) it was required that the dredging license should expire at the end of the season instead of running for a year after date of issue, as was previously the case; and in 1886 vessels were permitted to obtain a license after the beginning of the season at the rate of 50 cents per ton per month for the remainder of the season. The latter provision, however, was repealed in 1892.

The regulations now governing the licensing of dredging vessels are as follows:

> The comptroller of the treasury shall, upon application of any person who has been a resident of this State for twelve consecutive months next preceding such application, issue a license to such resident, and to no other person, to employ such boat in taking or catching oysters with scoop, dredge, or similar instrument, within the waters of Chesapeake Bay, Potomac River, and in Eastern Bay, outside of a line drawn from the southwest corner of Kent Point to Wade Point; *Provided*, That nothing herein contained shall authorize the taking or catching of oysters with scoop, dredge, or similar instrument, on any oyster bar within one and a half miles of Talley Point, Sandy Point, Hackett Point, Thomas Point, Holland Island Bar, and Three Sisters, nor within one and one-half miles of Holland Point Bar; nor of Swan Point Bar; nor between Poplar Island and the mainland of Talbot County, south of a line drawn from the north point of Poplar Island to Louis Point, on the mainland; nor north of a line drawn from the end of the south bar of Poplar Island to Paw Paw Cave, on Tilghman Island; nor within one-fourth of a mile west of Poplar Island; nor within one-half of a mile of Plum Point; nor within the boundary lines of any county, unless herein otherwise specified; which licenses shall hold good for one season only, and shall only authorize the catching of oysters between the fifteenth day of October and the first day of April, on which day the dredging season shall end and the license expire.
>
> The owner of such boat shall make oath before the comptroller, or his clerk, or if the owner be a resident of Baltimore City, he may make oath before the clerk of the court of common pleas, or if a resident of a county, he may make oath before the clerk of the circuit court for said county, that he is the bona-fide owner of such boat, to be described in the license; that he has been a resident of the State for the time hereinbefore prescribed; that there is no lien on said boat held by a non-resident, directly or indirectly, and that the said boat is not held or shall not knowingly be used with an intention to violate or evade the provisions of this law; and such applicant shall produce before the comptroller at the time of making such application the certificate of the taking of such oath and the custom-house tonnage, which tonnage the owner shall swear to. The master of such boat shall also make oath before the comptroller, or his clerk, or, if a resident of Baltimore City, before the clerk of the court of common pleas, or before the clerk of the circuit court for the county wherein he may reside, that he has been a resident of this State for twelve months next preceding the time of taking such oath.
>
> Before granting such license the comptroller shall receive for it from the applicant at the rate of $3 per ton for every ton the boat may measure, and the license shall be exhibited whenever called for by any officer of this State.
>
> The comptroller shall have painted, in black figures on white canvas, two sets of numbers corresponding to the license to catch oysters with dredge or any other similar instrument; each figure shall be 22 inches in length and of proportionate width, and the figures at least 6 inches apart; and he shall give to each person taking out such license two numbers thereof, one of which shall be securely sewed upon the starboard side and in the middle of that part of the mainsail which is above the close-reef, and the other number on the port side in the middle part of the jib, which is above the bonnet and reef; these numbers shall be placed in an upright position, and worn at all times during the dredging season, and returned at the end of the season, and shall not be canceled or defaced; and no other number shall be exposed to view or used than that which is furnished by the comptroller.

The penalties, which are fully defined in the statutes, are ample for the satisfactory enforcement of the regulations, dredging without license or on forbidden areas being punished with imprisonment of the captain from three to twelve months and a fine of $100 to $500 on the vessel employed.

The use of steam vessels has never been permitted on the public reefs in Maryland, and while at present there is no interdiction against the use of vessels propelled by other artificial force, as electricity, etc., such a regulation would doubtless be adopted as soon as practicable were the use of such vessels attempted. At no time has there been in Maryland a restriction on the size of the vessels or the weight of the dredges used in the "State waters."

The close seasons operative in this branch of the fishery since 1865 are shown in the following condensed statement:

Years.	Close season.
1865-1869	June 1 to Aug. 31
1870-1873	May 15 to Sept. 15
1874-1879	May 1 to Sept. 30
1880	April 1 to Oct. 14

The following table exhibits, according to the State records, the number of dredging licenses issued in Maryland since the adoption of the license system:

Table showing number of dredging licenses issued in Maryland.

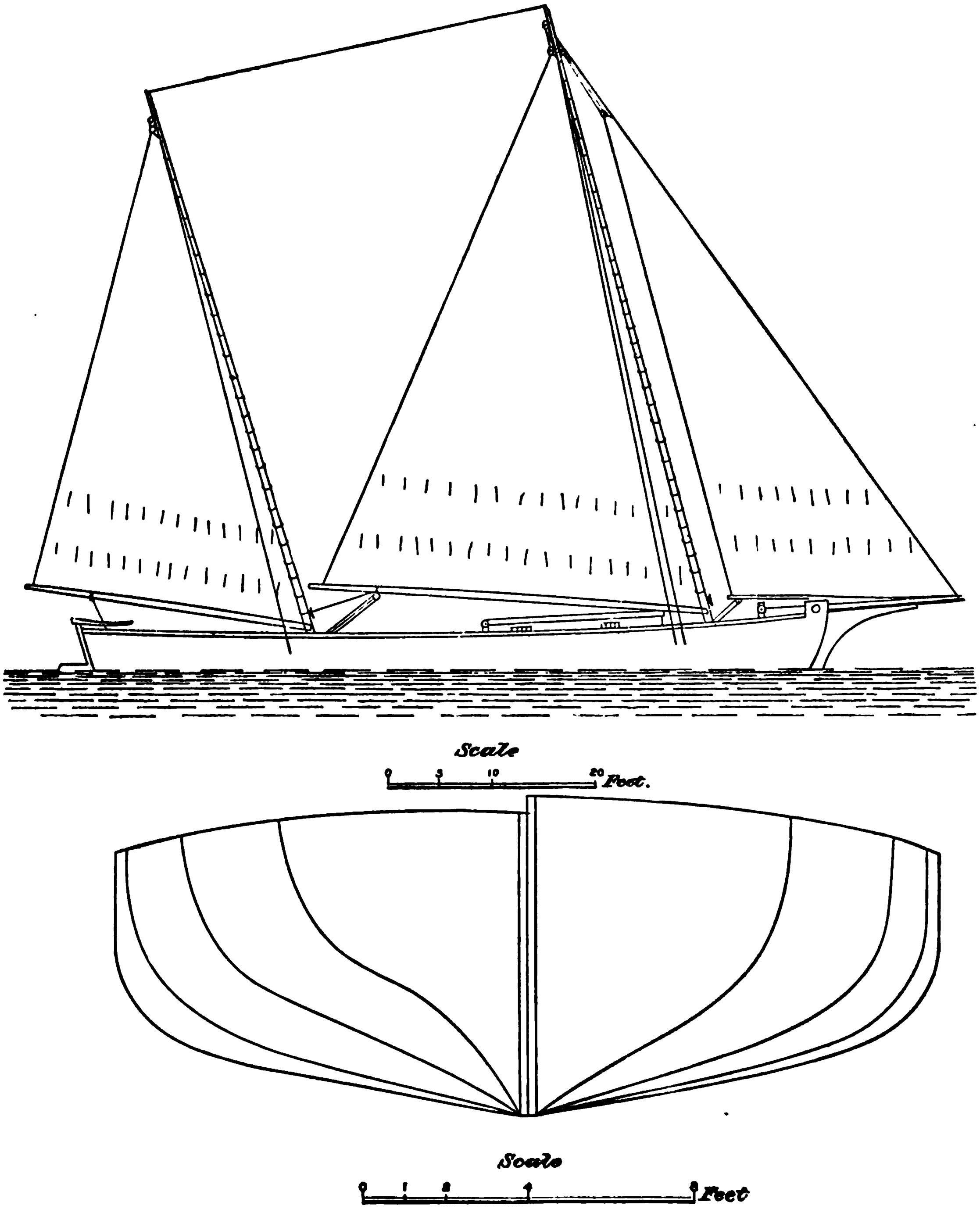
Season.	No. of licenses.	Season.	No. of licenses.	Season.	No. of licenses.	Season.	No. of licenses.
1865-66	391	1872-73	559	1879-80	327	1886-87	811
1866-67	401	1873-74	621	1880-81	531	1887-88	807
1867-68	438	1874-75	538	1881-82	728	1888-89	943
1868-69	563	1875-76	691	1882-83	674	1889-90	860
1869-70	642	1876-77	677	1883-84	501	1890-91	821
1870-71	637	1877-78	565	1884-85	955	1891-92	770
1871-72	597	1878-79	465	1885-86	879	1892-93	719

It will be observed that from 1878 to 1881 the number of licenses issued was much less than during the seasons immediately preceding and following. While it is true that a decrease did take place in the number of vessels dredging, yet it was scarcely so great as is indicated by the license list, and the decrease in the number of licenses issued was due to failure on the part of a number of the vessels to comply with the license regulations. This was largely due to the difficulty of convicting illegal dredgers. Under the law of 1878, the wet oysters and ropes lying on deck were not sufficient to convict offenders, but it was necessary therefor that sworn statements should be made that the dredges were hauled and that oysters, and not rocks or stones, were brought up thereby; but in 1880 this defect in the regulations was remedied.

The largest annual product from this branch of the oyster fishery was probably obtained in 1873-74 or 1875-76, with 1884-85 and 1888-89 following close behind.

The dredging-grounds.—The water area in Maryland on which this branch of the fishery is at present authorized approximates 1,300 square miles, of which about 121 square miles are covered more or less abundantly with natural oyster-reefs. The most valuable of these are located between Plum Point and Point Lookout on the Western Shore, on the Eastern Shore along Kent, Sharp, and Hooper islands, and on each side of the Potomac River. In the early part of the season the dredging vessels usually work off Kent and Sharp islands, and later, as the oysters on those reefs become less plentiful, the beds lower down the bay are resorted to.

The depth of water over the reefs varies from that scarcely sufficient to float the vessels down to 60 or more feet, but the average depth is from 15 to 30 feet. The mount of empty shells and débris on the beds amounts to something less than 1 bushel to every bushel of oysters. About 42 square miles of the natural reefs are located in the Potomac River, and are resorted to also by the oystermen of Virginia, who take therefrom about 500,000 bushels annually. The annual product obtained by Maryland oystermen from all the dredge reefs situated in "State waters"



CHESAPEAKE BAY BUG-EYE.

during the last five seasons has averaged 2,950,000 bushels, valued at $1,450,000, an average of 24,386 bushels and $11,990 to the square mile. About 200 of the dredging vessels work also under the scraping law in the "county waters" of Somerset, Dorchester, and Talbot counties, and catch therein annually about 500,000 bushels in addition to the foregoing.

The oysters obtained by the dredging vessels are generally larger and command better prices than those obtained from the tonging or scraping areas. But the condition of the dredging-ground during the last four years has not been as satisfactory as that of the tonging and scraping grounds. The implements and vessels are more effective, and the quantity of oysters left on the reefs has been growing smaller each year. On a number of the once prominent reefs profitable oystering has not been found for several years. This is true of the Western Shore from the "Steps" down to Cove Point, and to some extent of the "Lumps" and the Kent shore.

The boundaries of the dredging areas as defined by law must necessarily consist of imaginary lines, for the great extent of the water area of Maryland has up to the present time rendered a resort to buoying or similar indications too expensive for adoption. This fact, together with the frequent necessity for the dredging vessels to enter the small tributaries for harbor protection and other purposes, makes it practicable for the vessels, particularly upon dark nights or foggy days, to take oysters from areas outside of their authorized limits. It is quite difficult to convict offenders and even then suitable punishment is not always certain. The number of the dredging captains, however, who make a practice of oystering outside of their prescribed limits is small; but as long as the inducements to dredge on forbidden grounds is greater than the punishment therefor, some of the dredgers can not be prohibited from catching oysters from such reefs as yield them the greatest returns.

Dredging vessels and boats.—Distinct and peculiar classes of vessels and boats, long celebrated for their speed and beauty, have been evolved in the Chesapeake Bay for use in dredging. These range in size from the smallest craft barely able to carry two men with the small quantity of oysters they may catch in one day to large schooners 75 feet in length and measuring 70 tons, with a carrying capacity of 3,000 bushels. The value ranges from $80 to $7,000 each, and averages about $900, the tonnage averaging 20.76 in 1892–93. The largest vessel that has engaged in dredging during the last two or three seasons is the *A. H. Shultz*, of Baltimore, the length of which is 74.4 feet, breadth 23.5 feet, depth 7.4 feet, and tonnage 71.20, with a crew of 12 men.

The types of vessels employed in this branch of the oyster industry consist of bug-eyes, schooners, pungies, and large canoes and sloops. The bug-eye, which is peculiar to the Chesapeake, is a development of the canoe, from which it differs chiefly in having a sharp prow, from a peculiar feature of which it derives its name, and in being decked over from end to end with suitable hatchways and without bulwarks. The large bug-eyes can not be made of logs, but must be framed and planked. They range in length from 25 to 75 feet and in cost from $300 to $2,500, and carry from 50 to 1,800 bushels of oysters.

The schooners and large sloops do not differ materially from those employed along other portions of the Atlantic coast. Pungies are similar to the schooners, the chief difference being in the former having a fuller bow and sharper stern than the latter, facilitating the rapid tackings desirable in dredging across the oyster reefs.

During the summer many of these vessels find employment in transporting farm produce and other commodities obtained or utilized along the shores of the bay.

The following exhibit shows the number of the various types of vessels and boats employed in dredging during the season 1892–93:

Types.	No.
Sloops	32
Canoes, etc	91
Bug-eyes, schooners, and pungies	596
Total	719

The vessels and boats hailing from the Eastern Shore are generally in part or entirely owned by their respective captains, but the greater number of the Baltimore vessels are owned by merchants, commission sellers, etc. Of the 719 vessels and boats engaged in dredging during the last season, 1892–93, 324 were owned in whole or in large part by the captains in command of them.

The following tabular statement exhibits the number of owners of the vessels licensed to dredge in 1892–93, with their respective holdings:

Classification of owners.		No. of owners.	No. of vessels.
Men owning	1 vessel	296	296
	2 vessels	76	152
	3 vessels	34	102
	4 vessels	18	72
	5 vessels	7	35
	6 vessels	3	18
	9 vessels	1	9
	10 vessels	1	10
	12 vessels	1	12
	13 vessels	1	13
Totals		438	719

This statement shows that 4 men own 44 vessels, or one-sixteenth of the total number; 66 men own 271, or three-eighths of the total; and 142 men own 423, or three-fifths of the total dredging vessels and boats employed.

The following table, exhibiting for each county the number of dredging vessels and boats in each tonnage grade, is of interest, especially to persons desirous of effecting a tonnage limit on the vessels operating in the "State waters."

Table exhibiting by counties the tonnage grade of vessels engaged in dredging in 1891–92.

Counties.	Tonnage.													
	Under 5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	70–75	Total.
Somerset	11	72	82	63	43	33	22	12	15	5		3	1	362
Wicomico		1	1	2	1									5
Dorchester		25	1	2	2	3	1	3	3		1	1		42
Talbot		10		1		1								12
Kent				1				1						2
Baltimore		2	6	24	34	36	45	27	32	10	3	2		221
Anne Arundel	1	15	4	2	2		1	1						26
Calvert	20	15	2		2		1							40
St. Mary	39	12	1	1	2	3								58
Charles		1					1							2
Total	71	153	97	96	86	78	71	44	50	15	4	6	1	770

The average "length of life" of a dredging vessel is about thirty-five years. As this branch of the oyster fishery has been prosecuted less than that time, and as the number of vessels built each year indicates in a general way the prosperity of the fishery, the following table is presented, showing the years in which were built the vessels and boats employed in 1891–92:

Table showing the years in which were built the vessels dredging in 1891–92.

Counties.	1827	1835.	1840 to 1844.	1845 to 1819.	1850 to 1854.	1855 to 1859.	1860 to 1864.	1865 to 1869.	1870 to 1874	1875 to 1879	1880 to 1884.	1885 to 1889.	1890 to 1892.	Unknown	Total.
Somerset	......	......	......	5	11	12	14	32	61	42	88	61	24	12	362
Wicomico	......	......	......	......	1	......	......	1	1	......	1	......	......	1	5
Dorchester	......	......	......	......	......	......	1	4	5	6	18	4	2	2	42
Talbot	......	......	......	......	......	......	......	1	......	......	2	5	4	......	12
Kent	......	......	......	......	......	......	......	1	......	......	......	......	......	1	2
Baltimore	1	1	3	18	17	26	27	34	38	8	34	5	3	6	221
Anne Arundel	......	......	......	......	......	......	......	1	4	3	8	9	1	......	26
Calvert	......	......	......	......	......	......	......	1	3	6	11	9	4	6	40
St. Mary	......	......	......	......	......	......	1	3	7	8	12	9	4	14	58
Charles	......	......	......	......	......	......	......	......	......	......	......	......	......	2	2
Total	1	1	3	23	29	38	43	78	119	73	174	102	42	44	770

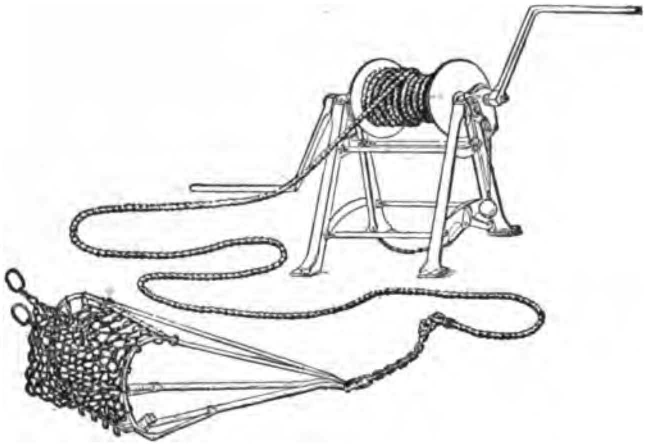
This table shows that from 1875 to 1879 and from 1885 to 1892 the inducements to build dredging vessels and boats were much less than during the periods immediately preceding, the number built during these thirteen years being an average of 16 per year, while from 1870 to 1874 and from 1880 to 1884 the average number each year was 29. In 1890–91 the oldest vessel engaged in dredging was the *Intrepid*, 32.16 tons, which was built in 1810 and is doubtless the oldest vessel in America. The *Juvenile*, 32.39 tons, the *Halcyon*, 17.02 tons, and the *William Washington*, 18.98, built, respectively, in 1827, 1835, and 1836, ranked next in the order of age. During the next season the *Intrepid* left the business to younger and more speedy boats, but the *Juvenile* and *Halcyon* remained in the fishery during that season and also in 1892–93.

For the purpose of exhibiting the distribution of the dredging vessels and boats the following table is presented, showing the number hailing from each county during the seasons noted:

Table showing by counties the number of vessels licensed during certain seasons.

Localities.	1868–69.	1886–87.	1888–89.	1891–92.
Somerset	238	355	444	362
Wicomico	12	15	16	5
Dorchester	46	33	38	42
Talbot	....	16	9	12
Queen Anne	1	1	1	....
Kent	1	8	11	2
Baltimore	240	290	298	221
Anne Arundel	20	26	25	26
Calvert	1	45	41	40
St. Mary	2	21	60	58
Charles	2	1	....	2
Total	563	811	943	770

Apparatus and methods.—Each vessel engaged in dredging oysters in Maryland is provided with two dredges and two "winders" or windlasses for hauling the same, excepting that the very small boats employed have only one dredge and one windlass. The average weight of the dredge is about 100 pounds, no restriction on the size having ever been made in this State. They range in width from 2 to 4 feet, with from 8 to 18 teeth, the greater number of them being 3 feet wide, with 12 to 14 teeth. The "winders" are securely fastened to the deck of the vessel about midship, one being located on each side. Opposite these and on the gunwales are placed rollers 3 or 4 feet in length to facilitate the lifting of the dredges. The average value of the dredges, winders, rollers, chains, and lines on each vessel is about $100. The winders employed on the better class of the vessels in the Chesapeake are so constructed that if the dredge should catch on some obstruction on the bottom the drum is automatically thrown out of gearing and the dredge rope allowed to run out.



CHESAPEAKE OYSTER DREDGE AND WINDER.

The vessel is controlled by the captain, who remains aft in order to attend to the steering and manage the sails; the mate, when one is carried, stands midship directing the manipulations of the dredges, which are lifted by the winders, operated by the common hands. The vessel is usually worked with the wind, and may dredge lengthwise or across the reefs. It requires from one to four weeks to obtain a load of oysters, the catch averaging from 20 to 80 bushels per day. Most of the vessels transport their catch to market, but some remain down the bay for months and sell their catch to the "buy" or transportation vessels. As they move from reef to reef, according to the condition and abundance of the oysters, frequently from 50 to 200 vessels may be sighted at work in a single locality. It is reported that the provisions used on the vessels are much better now than formerly, both in quantity and quality. The cost for an average-size vessel is now about $40 for a trip lasting three weeks.

Probably no question of economic importance connected with the fisheries has led to more dispute or to a wider difference of opinion among rival theorists and practical fishermen both of America and Europe than that relative to the effects of dredging upon oyster beds. The use of these implements beyond the productive powers of the reefs, when no provision is made for replacing breeding oysters thereon, is injurious; but the same is true of any other form of apparatus. Dredges may also injure some of the oysters by tearing them open or crushing them, but the number thus destroyed is probably not large on those beds operated on year after year. The oyster-culturists of New York and Connecticut find it to their advantage to use dredges many times the weight of those employed in Maryland. The use of these implements merely to stir up the oyster beds just prior to the spawning season, and thus to some extent clean the shells on the bed for the attachment of spat, is of much value. But after the spawning season the use of heavy implements is certainly injurious until the shells of the young oysters have acquired sufficient strength to resist being crushed by their action.

Men on dredging vessels.—The crew of a dredging vessel usually consists of the captain, mate, cook, and from two to nine common hands, according to the size of the craft. The captains are all citizens of the State, and the greater number of them are married and have homes in Baltimore or "down the bay." They are usually possessed of a little means and have a social standing in their local communities. Many of those residing in the counties have farms, to which their attention is devoted when not afloat. Others during the close season engage in the transportation of wood, farm produce, etc. Away from the Chesapeake the Maryland dredging captains are regarded as a reckless and lawless class of men. This does these men a great injustice; they are as peacefully disposed as the generality of mankind, engaged in a lawful and useful occupation, and obey the statutes as fully as the oystermen of any other State. But it is not surprising that out of 800 dredging captains there should be a few reckless and unprincipled persons, for this is generally the case in every other vocation. The mate or chief assistant is generally a man younger than the captain, from the same locality, and usually expects within a few years to be in full command of an oyster vessel.

As to the remaining members of the crew, some small vessels from the counties obtain men from the localities in which the vessels are owned or in which the captains live; but the great majority of vessels employ an entirely different class of men, who are in no sense baymen and to whom the dredging of oysters is frequently an episode rather than a pursuit. They have no peculiar knowledge of the business, being required merely to turn the winders that lift the dredges and to cull the oysters after they are brought on deck. So great discredit has been brought upon this branch of labor that none but the most destitute persons can be induced to do the work, and in order to man some of the vessels at times it is necessary to resort to means that strongly resemble impressment and violence. Very few of these men have homes; they come to Maryland at the opening of the dredging season from all parts of the country, without money and almost without clothes, being driven to the city to seek work by reason of the stress of weather. They usually hire out by the trip, which may last from ten to forty days, at a rate varying from $8 to $18 and provisions.

The captain of the vessel does not bargain with the men and frequently does not know of whom his crew consists until he is ready to proceed on the trip. There are persons in Baltimore who make a business of furnishing men for the vessels. They have small rooms in which are quartered the men seeking the work or whom they may have induced to accept of it. When these labor brokers receive an order to furnish a vessel with a certain number of men, they see that the men are properly on board, and for this service collect $2 for each man obtained, this fee being paid by the captain and afterwards deducted from the compensation of the laborer. The laborers are advanced a small sum of money, usually about one-fourth of the total wages, for the purchase of clothing, especially oilskins, and such other things as they may desire.

Less than 12 per cent of these common hands are natives of Maryland, and many are unable to speak the English language. From the statements given by each man at the offices of the shipping commissioners in Baltimore, in 1892, I have learned the nativity of 2.438 of them, this being exhibited in the following tabular statement:

Nativity of common hands on Maryland dredging vessels in 1892.

United States.	No. of men.	Foreign countries.	No. of men.
Maryland	292	Germany	461
Pennsylvania	257	Ireland	427
New York	226	England	112
Virginia	89	Poland	62
Massachusetts	86	Russia	46
New Jersey	42	Scotland	45
Connecticut	34	Austria	36
Illinois	23	British Provinces	18
District of Columbia	14	Sweden	17
Ohio	13	France	15
Georgia	10	Switzerland	14
Delaware	8	Denmark	11
Michigan	7	Spain	8
Rhode Island	6	Norway	8
California	5	Africa	5
Wisconsin	5	Italy	3
Alabama	5	Portugal	2
Maine	4	Holland	2
Kentucky	4	Wales	2
North Carolina	3	"At sea"	1
New Hampshire	3		
Texas	2		
Vermont	1		
South Carolina	1		
Tennessee	1		
Colorado	1		
West Virginia	1		
Total, United States	1,148	Total, foreign countries	1,295

While this does not exhibit the total number of men shipped during that season, yet the total proportionate representation from the various States and countries does not materially differ from that here presented. The fact is here disclosed that less than one-half of these men are natives of the United States and less than 12 per cent are natives of Maryland, each of two foreign countries supplying many more men than that State.

It should be observed that while it required only 1,964 persons to man the 221 vessels hailing from Baltimore city in 1891–92, yet the number of men shipped on those vessels during that season was much greater. This is due to the fact that many men made only one trip and others but two or three.

Prior to going on a trip these men are required to sign articles of agreement before certain officers, and from these papers it has been learned that out of a total of 992 men shipped during one month in 1892 only 413, or 43 per cent, were able to write their names. Of those born in America only 25 per cent were able to write, and of the foreign-born 55 per cent were similarly situated. The reason for the proportion of illiterate men being so much greater among Americans than among those of foreign birth is that many immigrants of fair education readily accept of this labor, while as a rule only the most destitute Americans resort to it. During the same season one vessel was manned by a crew of 9 men, representing 6 nationalities, and not one of the persons on board, including the captain, was born in America, only 3 were able to converse in English, and not one was able to read or write in any language. This, however, was very exceptional.

The following data, furnished by Surgeon-General Wyman of the U. S. Marine Hospital Service, showing the nature and extent of the accidents to which these men are subjected, are here presented. In estimating the value of these figures it should be remembered that Baltimore is but one of many ports of relief for Chesapeake Bay, and that if records were obtained from Crisfield, Cambridge, Oxford, Annapolis, Washington, and other points, the figures would be much larger. Only surgical cases are included in the list, no computation having been made of the number of cases of pneumonia, pleurisy, and rheumatism brought into hospital from the oyster vessels.

Summary of surgical cases from oyster vessels treated in hospital by the U. S. Marine Hospital Service at Baltimore, Md., in winters of 1882–83 and of 1883–84.

Character of injuries.	No. of cases.
Fractures caused by crank handles of winders	20
foreign bodies	7
falls on slippery decks, etc	14
Dislocation caused by crank handle	1
Frozen extremities	50
"Oyster-shell hands"	30
Wounds contused and lacerated caused by falls	16
foreign bodies	19
crank handles	15

Total fractures, 41 cases with 72 broken bones. Total surgical cases treated in hospital, 193. In addition to the foregoing a large number of cases were treated at the dispensary without being sent to hospital.

The "oyster-shell hand" is a severe inflammation caused by wound and poisoning from the oyster shells. The hand appears as if affected by a huge felon, and deep and free lancing is necessary in its treatment. The tendons and bones are often exposed and loss of one or more fingers sometimes results.

Much has been said about the brutality of the dredging captains and the severe treatment to which they subject their crews. But the captains are not wholly responsible for the sufferings of these men; as a rule they, as most other employers of labor, are humane and considerate of those in their service. Proof of this is found in the fact that when the men get in trouble on shore they frequently send to the captain of a vessel for relief, and some men return year after year to seek employment on the vessels. While in the aggregate the number of cases of harsh treatment may seem large, yet such is not the case when consideration is taken of the number of men employed and their entire unsuitability for the work. They are so unaccustomed to discipline that the exercise of that authority necessary on board of a vessel unavoidably produces some unpleasantness between the captain and the men. The very nature of the occupation, working upon slippery decks in freezing weather, together with the unskilled ability of these men, results in much suffering, for which the captain is in no sense blamable and for which, because of the financial interests involved if nothing else, his regret is second only to that of the unfortunate member of his crew. And when one investigates the life of these men when on shore and compares it with that led while on a dredging trip the natural inference is that in many instances the latter is the more comfortable, and that not infrequently the men are better off when on the bay than they are in the city.

The vessel-owners recognize the injury that the employment of this class of labor is doing to the reputation of their business and they would gladly welcome a change in the grade of men they employ. The payment of higher wages would of course secure better men, but the present profits of the fishery and the active competition with one another, which have produced this condition, will not admit of a few paying higher wages without concerted action, and that seems impracticable. Many methods of State regulations for effecting the desired result have been suggested, few of which have been considered of sufficient practical value for adoption.

The most noticeable effort to improve the condition of these men was made by act of 1888 (ch. 513), which provides for the appointment by the governor of a number of "shipping commissioners" in Baltimore and the large ports down the bay, whose duty it is to supervise the engaging of employés on vessels measuring over 10 tons, except such men as work on shares and residents of the county where the crew is shipped, the word "county" not applying to Baltimore City. These men are required to superintend both the engagement and discharge of the laborers, drawing up the contracts and seeing that they are fully complied with, receiving therefor a fee of 50 cents for each man shipped and 25 cents for each man discharged, one-half of these fees being deducted from the wages of the laborer and the remaining half being paid by the captain.

Financial results.—The profitableness of the dredging industry varies much from year to year, according to the prices of oysters and their abundance on the beds to which this branch of the fishery is confined. In general it is not so profitable now as it was twenty years ago. On account of the large number of vessels engaged the marketable oysters are mostly secured during the first few months of the season, and the vessels do not find it profitable to work as late in the year as they formerly did, a large number of them during the last few seasons leaving this branch of the business about Christmas.

The length of time now required to obtain a cargo is also greater than formerly, this now being fifteen to twenty-five days, whereas eighteen and twenty years ago a cargo could usually be secured in a week or ten days. This, of course, reduces the profits very materially, and the books of the vessel-owners indicate that after paying all expenses, including wear and tear on the vessels, the profits are not very great, and vessel property of this class is now comparatively cheap in the Chesapeake.

If the vessel be not owned by the captain, the latter, with very few exceptions, runs it on shares, the arrangement being sometimes as follows: Out of the bill of sale are paid the wages, food bill, expenses of sale of oysters, etc., and from what is left the captain receives 40 per cent and the vessel-owner 60 per cent. A more frequent method is for the owner of the vessel to receive one-third of the value of the catch and the captain to take the balance and pay all expenses. Many other forms of agreement exist. These ordinarily net the captain from $35 to $85 per month, according to the abundance and prices of oysters.

The mate and the cook ship on wages, varying from $15 to $25 per month, with board. The common hands are usually paid by the trip at rates varying from $8 to $18, according to the abundance of employés and the ability of the men secured. The number of men available for this work appears to be smaller each year, and as a consequence the wages are increasing somewhat. In 1890–91 the average per trip was $13.69, and in 1891–92 it was $14.43, these figures representing the condition for the fleet. The better class of common hands ship by the month, at rates varying from $12 to $25, but the number of such men is small. On a few vessels from the counties the laborers work on shares, the agreements usually being as follows: The provision bill, commission sellers' charges, and similar expenses are first paid, then the owner of the vessel receives one-third of the balance and the captain receives a bonus of $15 to $25, after which the captain and members of the crew share alike.

SCRAPING.

Historical notes.—The expression "scraping" is here applied to the taking or catching of oysters by means of a scrape or dredge within the waters of a county, "dredging" being applied to the same form of fishery when prosecuted in the "State waters." It is termed scraping from the fact that the vessels used are generally much smaller than those employed in the "State waters," and consequently must employ lighter dredges, which are known as scrapes. This branch of the oyster industry is prosecuted only in certain portions of three counties of the State, viz, Somerset, Dorchester, and Talbot. It originated in Somerset in 1854, eleven years before dredging was authorized in "State waters." Sixteen years later the use of scrapes was authorized on the southern shore of Dorchester County, and in 1874 on the northern shore of that county and in portions of Talbot.

The regulations permitting the use of scrapes in Somerset (L. 1854, ch. 4) authorized any citizen of that county, after obtaining a license therefor, to use a vessel owned in the county to "catch oysters with a scrape or drag in any of the waters of said county, not parcel of any creek or river, not within 200 yards distance from the shore, and in waters not less than 21 feet deep." The license, which was issued by the clerk of the circuit court, was operative for one year without close season, and cost $15 for each vessel, all moneys arising therefrom being paid into the school fund of the county, excepting 50 cents for each license, which went to the issuing clerk as his fee. As a large portion of Tangier Sound is situated within the limits of Somerset, this act opened to the use of the scrapemen a large area of very valuable oyster-ground.

By the act of 1867 (ch. 129) the restriction against scraping in Somerset within less than 200 yards of the shore and in waters less than 21 feet deep was removed, and the license fee was reduced from $15 to $10. But this act also required that before receiving a license to scrape oysters the applicant should obtain from the comptroller of the State treasury a dredging license, in accordance with the general license law of the State, which had then been in force for two years, and it was made unlawful for anyone to scrape for oysters in any creek, cove, or inlet, or during the period in which dredging was interdicted in the bay, viz, June 1–September 1.

Prior to 1877 the oystermen of Somerset enjoyed the privilege of scraping in a large portion of Pocomoke Sound, but after the award of the boundary commission of that year their operations were confined to the Maryland side of the new line, giving them only 23 square miles of area on the Pocomoke side of the county. In 1880 (ch. 445) the use of scrapes in this portion of the Pocomoke Sound was prohibited.

In 1884 the annual rate required to be paid for scraping licenses in this county was changed from $10 each vessel to $2 per ton of measurement, and it was further required that only such vessels as measured over 10 tons should obtain a State license before being licensed to use scrapes. In 1886 (ch. 489) the scraping license fee was reduced to $1 per ton and in the same year the close time was changed to April 1–September 30.

By act of 1890 (ch. 629) the general assembly authorized an election to be held on May 13 of that year, in certain districts of Somerset, to decide whether to prohibit scraping in the waters of that county. The vote was favorable to the interdiction, but the courts decided that the procedure was irregular.

The scraping law operative on the southern shore of Dorchester County originated in 1870 (ch. 129), sixteen years after the privilege was first enjoyed in Somerset County.

This law required the clerk of the circuit court of Dorchester to issue licenses to boats and vessels owned by citizens of that county, authorizing them to use scrapes in certain waters on the southern shore thereof between October 1 and April 30 in each year. It was required that the licensed boat should not exceed 5 tons measurement, and the license fees were established as follows: For every boat measuring less than 20 feet in length the sum of $5; from 20 to 25 feet, the sum of $8; from 25 to 30 feet, $10, and all over 30 feet in length the sum of $20, the revenue derived therefrom being paid into the State treasury. In 1872 (ch. 181) it was required that the license fees thereafter should be paid into the treasury of the county school fund.

In 1874 (ch. 214) the scraping law for southern Dorchester was modified, the principal changes being in raising the limit of measurement of the craft employed from 5 to 10 tons, changing the license fee to $3 per ton, and in not permitting scraping within 200 yards of the shore, nor from May 1 to September 14. But in 1878 the license fee was reduced to $2 per ton, and soon thereafter all boats measuring under 5 tons were required to pay a fee of $8 each, without regard to their actual measurement. In 1882 (ch. 327) the close time for scraping in these waters was changed from May 1–September 14 to April 1–September 30, and in 1892 (ch. 278) it was again changed to March 1–September 30.

The law authorizing scraping within certain limits of Talbot County, and which is common to that county and the northern shore of Dorchester County, originated in an act of 1874 (ch. 437) authorizing any twelve-month resident of either county to obtain a license permitting him to catch oysters from September 15 to April 30, by means of scrapes, in certain waters of those two counties. The license was obtainable from the clerk of the circuit court for the county of which the applicant was a resident, and no provision was made for licensing vessels measuring over 10 tons. The fee was placed at $3 per ton, the revenue derived therefrom being devoted to the school fund of the county in which the license was issued. In 1876 (ch. 405) the scraping season was changed to September 15–May 31, and in 1878 (ch. 359) the license fee was reduced to $2 per ton. By act of 1884 (ch. 468) all boats measuring less than 5 tons were required to pay $8 license fee, without reference to their actual measurement, and the scraping season in the waters referred to was changed to October 1–March 31, it being again changed in 1892 (ch. 278) to October 1–March 1.

The following statement exhibits in a condensed form the close seasons that have been operative in scraping in each of the three counties in which this form of fishery is authorized:

Somerset.		Dorchester, southern shore.		Dorchester, northern shore, and Talbot.	
Years.	Close seasons.	Years.	Close seasons.	Years.	Close seasons.
1854–66	....	1870–73	May 1–Sept. 30	1874–75	May 1–Sept. 14
1867–85	June 1–Sept. 1	1874–81	May 1–Sept. 15	1876–83	June 1–Sept. 14
1886–93	Apr. 1–Sept. 30	1882–91	Apr. 1–Sept. 30	1884–91	Apr. 1–Sept. 30
		1892–93	Mar. 1–Oct. 30	1892–93	Mar. 1–Sept. 30

The following table shows, so far as practicable, the number of scraping licenses issued in each county since the origin of this branch of the fishery. Much search has been made to find the record for Somerset from 1854 to 1869, but without success. With this exception, the list is complete:

Table showing number of scraping licenses issued in Maryland.

Season.	Somerset.	Dorchester.	Talbot.	Total.	Season.	Somerset.	Dorchester.	Talbot.	Total.
1869–70	283	....	....	283	1881–82	173	153	83	409
1870–71	350	125	......	484	1882–83	278	177	64	519
1871–72	453	130	....	583	1883–84	262	218	64	544
1872–73	276	132	....	408	1884–85	469	310	100	879
1873–74	224	106	....	330	1885–86	370	402	125	897
1874–75	322	149	59	530	1886–87	428	334	93	855
1875–76	209	180	40	429	1887–88	337	373	85	795
1876–77	165	142	47	354	1888–89	262	433	85	780
1877–78	59	142	27	228	1889–90	356	502	105	963
1878–79	151	157	34	342	1890–91	632	550	116	1,298
1879–80	57	134	29	220	1891–92	640	582	78	1,300
1880–81	292	148	30	470	1892–93	647	483	102	1,232

Owing to a defect in the law operative at that time, a number of Somerset scrapemen from 1877 to 1880 engaged in this fishery without a license, and while the foregoing figures embrace all the licensed boats and vessels, it does not for those years include all that engaged in scraping. The defect was remedied in 1880, and since then there has been little, if any, difference between the number of boats licensed and the number actually at work.

The following table exhibits, by counties, the amount of fees paid for scraping licenses during each of the last five seasons:

License fees paid for scraping from 1889 to 1893.

Seasons.	Somerset.	Dorchester.	Talbot.	Total.
1888–89	$1,807.31	$5,222.52	$1,344.46	$8,374.29
1889–90	2,540.83	6,211.26	1,688.34	10,440.43
1890–91	6.786.20	6,584.75	1,806.00	15,176.95
1891–92	4,463.01	7,937.00	1,267.92	13,667.93
1892–93	5,205.22	6,468.30	1,660.22	13,333.74
Total	20,802.57	32,423.83	7,766.94	60,993.34
Annual average	4,160.51	6,484.76	1,553.39	12,198.67

Grounds, area, etc.—The total water area of the counties in which scraping is authorized is 510 square miles, and the area used by the scrapemen 277, of which the area more or less covered with natural oyster-ground approximates 80 square miles. The following tabular statement exhibits these data for each of the three counties:

Counties.	Water area.	Scraping area.	Reefs in scraping area.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*
Somerset	183	112	39
Dorchester	207	118	26
Talbot	120	47	15
Total	510	277	80

The depth of water over these reefs averages about 32 feet, although in isolated places it may attain 100 feet. The general condition of the reefs in the three estuaries in which this fishery is prosecuted, viz, Tangier Sound, Choptank River, and Eastern Bay, has already been noted (see pp. 220–226). During the last five seasons the scraping areas have been in much better condition than the dredging-grounds, this being particularly true of the Choptank River, and they are naturally more productive than the tonging areas. During the last eight years no branch of the oyster fishery has been more prosperous than this, and its extent during the last four seasons has been far greater than ever before. The average annual product of all the scraping-grounds of the State during the last five seasons has been about 3,250,000 bushels, an average of 40,625 bushels to the square mile. Of this amount about 500,000 or more bushels annually have been obtained by dredging vessels working at the time under scraping licenses.

Boats and vessels.—The boats and vessels employed in scraping number about 1,250, all of which are propelled by means of sail. They comprise the various types utilized in the tonging and dredging branches of the oyster fishery. As a general thing they are larger than those used in tonging and smaller than those engaged in dredging. The total value of those in use in 1892–93 approximated $650,000.

In Talbot and Dorchester counties no vessels measuring over 10 tons are permitted to engage in this branch of the oyster industry, while in Somerset no restrictions are placed upon the size of the vessels employed, and nearly one-fifth are over 10 tons measurement. The average size of the craft in the two former counties is about 7 tons, and in Somerset it is 8.07 tons. The number of vessels engaged in scraping in this county in 1892–93 and measuring over 10 tons was 119, the tonnage of which was 2,087.23, an average of 17.53 to the vessel; and the number under 10 tons was 528, the tonnage of which was 3,117.99, an average of 5.91. Each one of the vessels measuring over 10 tons was required to obtain license to dredge in "State waters," in addition to their county scraping license, before being authorized to scrape in the waters of Somerset. The largest vessel engaged in this branch of the fishery in that county in 1892–93 was the *Edna Earl*, which measured 40.76 tons.

The limit on the size of the vessels permitted to scrape in Dorchester and Talbot counties has had a peculiar effect on the size and model of those employed, the dimensions, which largely increase the tonnage of the vessel under the present form of measurement, as depth and breadth, being reduced as much as practicable. And it is stated that resort is also had to "dunnage" and other methods for reducing the measurement within the legal limit, and that vessels are employed in those counties which if built upon ordinary lines and models would measure 12 or even 15 tons.

The same complaint with respect to "dunnage," etc., prevails to a certain extent in Somerset, for while no limit is placed upon the size of the vessels permitted to be used in that county, yet if the vessel measures over 10 tons it is required to obtain, in addition to the scraping license, a State dredging license at the rate of $3 per ton. This, however, gives them also the privilege of dredging in the "State waters," which is of value when the reefs therein are producing more abundantly than the county reefs. In order to dredge in the "State waters" a number of the scraping vessels under 10 tons also during certain seasons obtain a dredging license. In 1891–92 the number of vessels doing this from Somerset was 80, from Dorchester 22, and from Talbot 9. These, together with the Somerset vessels measuring over 10 tons, make a total of about 220 of the 1,250 scraping boats and vessels employed also in dredging.

The scrapemen.—Except on the large vessels owned in Somerset County, the men employed on the boats and vessels engaged in the scraping branch of the oyster fishery are quite similar in characteristics and social standing to the tongmen. They mostly reside in houses along the shores of the waters where they operate. Some of them during the close seasons engage also in farming or in other industries prosecuted in their native counties, which give opportunity for a few days' employment at odd times. They usually return to their homes every night and their boats do not frequently leave the waters in which they work, the catch being either delivered at the adjacent marketing houses or sold to the transporting vessels.

The men employed on the large vessels from Somerset County differ in little respect from those engaged in dredging, and are subject to the same regulations with reference to employment as provided by act of 1888. ch. 513.

OYSTER-CULTURE IN MARYLAND.

Historical notes.—The various modes by which the natural oyster-reefs in Maryland are being utilized have been discussed, and the attempts that have been made to utilize the barren areas now remain to be described. Little in this line has been done in Maryland, and that little has been almost entirely confined to the bedding or planting of small oysters on a few restricted areas and with much uncertainty of harvesting a crop. Innumerable efforts have been made to enact a system of regulations properly authorizing and encouraging ostreiculture, but these efforts have fallen far short of their aim.

The experience in Maryland in this respect has not been peculiar, for the course of ostreiculture has never run smooth. The very first operations in this line of which we have any knowledge met with opposition from persons who considered them an encroachment upon public customs. These operations were prosecuted in Rome about two thousand years ago, and Pliny, who wrote much concerning oysters, makes the following reference to them:

> The first person who formed artificial oyster beds (*ostrearium vivoria*) was Sergius Orata, who established them at Baiæ in the time of L. Crassus, the orator, just before the Marsia war (*cir.* B. C. 95). This was done by him, not for the gratification of gastronomy, but of avarice, as he contrived to make a large income by this exercise of his ingenuity. * * * He was the first to adjudge the preëminence for delicacy of flavor to the oysters of Lake Lucrinus, for every kind of aquatic animal is superior in one place to what it is in another. * * * The British shores had not as yet sent their supplies at the time when Orata thus ennobled the Lucrine oysters. At a later period, however, it was thought worth while to transport oysters all the way from Brundisium, at the very extremity of Italy; and in order that there might exist no rivalry between the two flavors a plan has been recently hit upon of feeding the oysters of Brundisium in Lake Lucrinus, famished as they must naturally be after so long a journey. *

A certain Considius thought, however, that Orata was encroaching too much on public property in his operations on the shores of the lake, and the latter was compelled to resort to the courts to defend his created industry.

It is apparent that the early legislators of Maryland had some conception of the possibilities of extending the oyster industry by encouraging private enterprise in planting, for the legislation on this subject dates back to 1830, this being the third State of the Union to recognize private ownership in planted oysters. This recognition was provided in an act dated February 16, 1830 (L. 1829–30, ch. 87).

This act, the groundwork of all subsequent legislation in Maryland on this subject, was in substance as follows: Any citizen of the State was authorized under certain regulations to appropriate in any of the bays or creeks situated within the county of which he was a resident an area or areas, not exceeding 1 acre in extent, for his exclusive use in planting or growing oysters or other shellfish, the said location to be not an oyster bed and to be distinctly defined by stakes or other proper marks, and to be described under oath, said description to be recorded in the office of the clerk of the circuit court of the county. The right to the location ceased on the failure of the preëmptor to each year deposit thereon "sufficient oysters or other shellfish to preserve the growth of the bed." The owner of lands bordering a creek not exceeding 100 yards in width was also given exclusive right to use the same for a similar purpose; and the unauthorized removal of oysters from any of these preëmpted areas was declared a misdemeanor.

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* Nat. Hist., vol. VI, p. 469, ed. Bohn.

While New Jersey and Rhode Island were in point of time ahead of Maryland in authorizing the planting of oysters, yet the regulations adopted by the latter conform more to the present recognition of the needs of a planting industry.

The following list of dates showing the time of the recognition or granting by legislative enactment in each of the United States of some form of private right in planted oysters is of interest:

Rank.	State.	Date.	Reference.
1	New Jersey	1820, June 9	L. 1820.
2	Rhode Island	1827, October	L. 1827, ch. 5.
3	Maryland	1830, February 16	L. 1829–30, ch. 87.
4	Connecticut	1842, June 10	L. 1842, ch. 38.
5	Massachusetts	1845, March 17	Private L. 1845, ch. 138.
6	South Carolina	1847, December 17	L. 1847–48, ch. 3024.
7	Delaware	1849, February 28	L. 1849, ch. 414.
8	Virginia	1849, March 16	L. 1848–49, ch. 125.
9	Maine	1849, August 15	L. 1849, ch. 142.
10	California	1852, April 28	L. 1851–52, ch. 117.
11	Georgia	1856, February 18	L. 1855–56, ch. 8.
12	Mississippi	1856, March 11	L. 1856–57, ch. 95.
13	New York	1859, April 18	L. 1859, ch. 468.
14	Oregon	1862, September 27	L, 1862.
15	Alabama	1872, February 28	L. 1871–72, ch. 28.
16	Washington	1873, November 5	L. 1873.
17	Texas	1879, March 8	L. 1879, ch. 28.
18	Florida	1881, January 29	L. 1881, ch. 3615.
19	North Carolina	1883, March 9	L. 1883, ch. 332,
20	Louisiana	1886, July 8	L. 1886, ch. 106.

There are official records in many of the Maryland counties, and particularly in Somerset, indicating that some of the residents immediately availed themselves of the privilege of preëmpting planting-grounds, but no data exist to show that the planting attained any commercial extent.

In 1842 (L. 1841–42, ch. 270) further provision was made for oyster-planting in this State, and citizens owning lands lying on any navigable waters, the lines of which included any cove or portion of such waters not navigable by licensed vessels, were given absolute right to all deposits of oysters or other shellfish that might be made by them thereon, and by act of 1846 the provisions of this law were extended so as to cover navigable waters similarly situated.

In 1843 (L. 1842–43, ch. 4) an act local to Worcester County was passed authorizing any resident of that county to preëmpt 2 acres of ground in Parker Bay, situated within the limits of Worcester County, and after having said area properly surveyed and the notice of preëmption recorded among the county records, to hold the same for planting oysters or other shellfish for a period of five years from the date of the act; and persons unlawfully removing oysters from such preëmpted areas were guilty of theft. But in 1845 (L. 1844–45, ch. 163) the foregoing act was repealed and in 1846 (L. 1845–46, ch. 40) an enactment was passed identical to the one of 1843, except that the limit of preëmption was fixed at one acre instead of two.

The act of 1865 (ch. 161), by which was adopted the oyster-license system, affected to some extent the planting regulations by increasing the limit of preëmption to 5 acres, but it required the preëmptor to be a resident land-owner. Thus each of the three provisions authorizing persons to plant oysters required the preëmptor to be the owner of lands on the foreshores. But in 1867 the provision authorizing the preemption of 5-acre lots was extended (taking effect January 1, 1868) to any citizen without reference to his ownership of lands bordering the water.

As the regulations expressly forbade the preëmption of natural reefs, many locations after being planted on at much expense were, even after a lapse of two or three years, claimed by the oystermen to be natural beds, and were thereupon thrown open for the use of the public. This resulted in some hardships and in much ill-feeling between the planters and the neighboring oystermen. In order to remedy this the general assembly provided in 1874 (ch. 181) that six months' peaceable and legal possession should constitute a good and sufficient title to the ground so far as was authorized by previous enactments, even though such location should be a natural reef, and in 1884 peaceable possession for twelve months was required.

By act of 1876 (ch. 277) an exception was made to the general planting law and each citizen of Worcester County was authorized to preëmpt of the barren grounds within the waters of that county an area not exceeding 5 acres for oyster-planting purposes, and to hold the location by keeping it plainly marked with bushes, stakes, or buoys, without being required to record a description thereof.

The act of 1890 (ch. 269) provided an elaborate planting law for Somerset County, in which the appointment was authorized of a body to be known as "oyster commissioners," who should, when requested so to do, examine and determine whether a desired location is a natural oyster-reef. Further provision was made in reference to fees to be paid, transfer of title, etc., also the following: "It shall not be lawful for any person or persons to locate or appropriate any water or bottom thereunder for the purposes set forth in this act, where the said bottoms are grassy or suitable for the catching of crabs." But this entire act was repealed at the next session of the general assembly (L. 1892, ch. 662) and the general planting law was reëstablished in that county.

It was provided by act of 1888 (ch. 505) that in case of the death of the preemptor of a lot his executors or administrators should have exclusive use of the location for three years. Prior to that enactment the lot and the oysters thereon reverted to the public immediately on the death of the owner, so far as the law was concerned, but in practice more liberality prevailed. A regulation local to Kent and Queen Anne counties was enacted in 1890 (ch. 333) permitting a preëmptor in case of insolvency to assign his lot for a period of three years. Except under one of these two provisions no authority at present exists for a transfer of title to an oyster-planting lot in Maryland.

From a perusal of the foregoing it is observed that the only changes of material value made in the planting regulations of this State since the original enactment of sixty-three years ago is an extension of the preëmption limit from 1 to 5 acres.

Except in Worcester County, in which the previously mentioned local enactment of 1876 is in force, the oyster-planting law now operative in Maryland is as follows:

> The owner of any land bordering on any of the navigable waters of this State, the lines of which extend into and are covered by said waters, shall have the exclusive privilege of using the same for protecting, sowing, bedding, or depositing oysters or other shellfish within the lines of his own land; and any owner of land lying and bordering upon any of the waters of this State shall have

power to locate and appropriate in any of the waters adjoining his lands one lot of 5 acres for the purpose of protecting, preserving, depositing, bedding, or sowing oysters or other shellfish; any male citizen of full age of this State shall have power to locate and appropriate and hold one lot of 5 acres, and no more, in any waters in this State not located or appropriated: *Provided*, Thirty days' notice, in writing, shall be given the owner or occupant of land bordering on said waters proposed to be located, that the owner or occupant may have priority of claim; and if such owner or occupant shall fail to locate or appropriate the water mentioned in said notice within thirty days after receiving the same, then it shall be open and free to anyone, under the provisions of this section: *Provided, also*, That the said location or appropriation shall be described by stakes, bushes, and with the name of the owner on a board fastened to a pole or stake on or within the appropriated oyster land, or by other proper and visible metes and bounds, which description shall be reduced to writing, under the oath of some competent surveyor, and recorded at the expense of the party locating or appropriating the same, in the office of the clerk of the circuit court for the county wherein such land may be located: *And provided also*, That such location and appropriation shall not injure, obstruct, or impede the free navigation of said waters: *And provided*, That no natural bar or bed of oysters shall be so located or appropriated, and that twelve months' peaceable possession of all locations of oyster-grounds under the laws of this State shall constitute a good and sufficient title thereto; but should anyone within twelve months be charged with locating or appropriating any natural bed or bar hereinbefore prohibited, the question may be at once submitted by any person interested to the judge of the circuit court for the county where such question shall arise, who, after having given notice to the parties interested, shall proceed to hear the testimony and decide the case; and if his decision be in favor of the party locating said 5 acres, said decision shall be recorded with the original record of said 5 acres, and shall in all cases be conclusive evidence of title thereto: *Provided also*, That if any stakes or bushes used as bounds shall be removed by accident or design it shall not excuse any person from wrongfully taking such oysters if he knew the grounds to have been located and appropriated; but any title or pretended title to more than 5 acres, or otherwise contrary to this section, held or claimed by any person is hereby declared to be fraudulent and void: *Provided*, That no non-resident of this State shall be entitled to avail himself of the provisions of this section, whether he be sole or part owner of any land in this State; and in case of the death of any citizen who may have located and appropriated any lot under the provisions of this section his executors or administrators shall have the exclusive use, possession, and control of such lot as fully as the person so dying had for the purpose of protecting, cultivating, and removing the oysters planted on said lot for the period of three years from the date of the death of the person appropriating such lot; and any person committing a trespass upon said lot, or taking oysters bedded thereon, without the consent of such executor or administrator, shall be liable to the penalties imposed by this article for taking bedded oysters.

If any creek, cove, or inlet, not exceeding 100 yards at low water in breadth at its mouth, make into the lands, or if any creek, cove, or inlet of greater width than 100 yards at low-water mark, make into the lands, the owner or other lawful occupant shall have the exclusive right to use such creek, cove, or inlet when the mouth of said creek, cove, or inlet is 100 yards or less in width; and when the said creek, cove, or inlet is more than 100 yards in width at its mouth at low water, the said owner or other lawful occupant shall have exclusive right to use such creek, cove, or inlet so soon as said creek, cove, or inlet in making into said land or lands shall become 100 yards in width at low water, for preserving, depositing, bedding, or sowing oysters or other shellfish, although such cove, creek, or inlet may not be included in the lines of any patent; and in all such cases such right of the riparian proprietor shall extend to the middle of such creek, cove, or inlet.

That it shall be unlawful, without authority from the owner, for any person or persons to take or catch planted or bedded oysters, knowing them to be so planted or bedded, or to remove, break off, destroy, or otherwise injure or alter any stakes, bounds, marks, buoys, or other designation of any said beds; any person or persons violating the provisions of this section shall be guilty of a misdemeanor, and on conviction before a circuit court or a justice of the peace for the county where the oysters were bedded, shall be fined not less than $10 nor more than $200, or be sentenced to the house of correction for a term of not less than three months nor more than one year, at the discretion of the judge or justice trying the same.

Planting lots preëmpted.—Prior to the enactment of 1867 comparatively few preemptions of lots had been made either under the 1-acre law of 1830 or the 5-acre law of 1865, and the title to most of those had been permitted to lapse. It is doubtful if more than 350 acres had been located in the State at the time of the aforementioned enactment. Some of the lots were located as early as 1830, this being the case in Somerset County particularly, while in Worcester County the greater number of the preemptions were made between 1840 and 1850. Immediately following the adoption of the 5-acre regulation of 1867, and each year thereafter, a number of locations were and have been made.

The following table, compiled from the various county records, exhibits the area of ground preëmpted during each year in each of the counties of the State:

Table exhibiting by counties the number of acres of oyster-planting ground preëmpted annually in Maryland.

Years.	Somerset.	Wicomico.	Dorchester.	Talbot.	Queen Anne.	Kent.	Anne Arundel.	Calvert.*	St. Mary.	Charles.	Worcester.†	Total.
1868 and prior	237	....	40	35	....	....	....	....	24	....	80	416
1869	61	....	9	3	....	....	....	....	8	....	....	81
1870	159	....	18	7	5	....	15	....	12	....	....	216
1871	369	....	243	....	....	....	....	....	16	....	....	628
1872	131	....	58	35	....	....	....	....	12	....	....	236
1873	118	....	86	49	24	....	....	....	32	....	2	261
1874	106	....	27	42	5	....	....	....	24	....	2	206
1875	86	10	99	7	10	....	....	....	4	....	....	216
1876	106	5	9	3	8	....	....	....	8	....	....	139
1877	168	5	....	3	....	....	....	....	12	....	....	188
1878	12	2	31	....	39	....	10	....	....	....	....	94
1879	159	5	108	3	....	....	19	....	28	....	....	322
1880	24	97	54	21	110	....	5	....	53	....	....	364
1881	....	60	144	63	5	....	....	....	12	....	....	284
1882	....	....	42	31	....	....	11	20	94	....	....	198
1883	20	35	27	24	7	4	13	42	53	....	....	225
1884	266	....	31	10	....	....	24	20	86	....	....	437
1885	377	84	40	3	3	5	12	10	4	....	....	538
1886	426	65	45	7	....	....	4	12	4	....	....	563
1887	131	64	....	7	....	11	17	....	8	....	....	238
1888	32	25	18	10	....	....	15	....	16	....	....	116
1889	36	50	40	7	5	5	8	....	12	....	....	163
1890	82	....	180	21	15	....	16	89	28	....	....	431
1891	336	40	130	45	56	14	28	113	12	....	....	774
1892	167	30	325	32	23	20	8	50	20	....	....	675
Total	3,609	577	1,754	468	315	59	205	356	582	....	3,084	11,009

* Records of Calvert County prior to 1882 were destroyed by fire.

† About 8,900 acres held under law of 1876, ch. 277, without filing papers.

Notwithstanding all this ground was ostensibly preëmpted for the planting of oysters, only a small part of it is now in actual use for that purpose. In fact, a large portion of it has never been used for planting purposes and was not appropriated with that object in view, many lots being located by the owners of the adjacent estates in order to prevent outsiders from operating on the margin of their property.

Some of the lots have, through error or otherwise, been located two or more times, and the descriptions filed are not always such as would give a surveyor a correct understanding of their locations, they frequently surrounding the lots with almost every impossible engineering description.

The scene of the most extensive oyster-planting in Maryland is not in the Chesapeake region, but on the shores of Worcester County in the Sinepuxent Bay. This is the only water area in Maryland not tributary to the Chesapeake, being on the ocean side of the Eastern Shore or "Mavirdel" peninsula, and emptying directly into the ocean. The planting of oysters in these waters originated on a small scale in 1842; but the extent on which it was then conducted was almost insignificant, the product being utilized entirely in the local trade.

About 1875 the rapidly diminishing product of the public beds in these waters led to an extension of the planting industry, which quickly increased until 1880, which was probably the most successful season known in the planting industry of the county as regards the profits of the persons engaged. From that time the industry decreased in extent because of the increasing mortality each year among the oysters planted. This may to some extent have been due to their overcrowded condition and a lack of sufficient food, but more likely to the malaërated condition of the water and the large amount of vegetable and mineral sediment in the bay.

The industry is still prosperous and conducted with as much energy, although probably not with so much care, as in any of the Northern States. The seed oysters are obtained from the natural reefs in this county, the ocean shore of the counties of Accomac and Northampton, Virginia, and the tributaries of the Chesapeake. The cost delivered on the grounds ranges from 15 to 45 cents per bushel, according to the quality and the locality whence obtained. About 250 to 550 bushels are planted to the acre, and they are permitted to remain from one to three years. While each person is authorized to preëmpt only 5 acres of ground, yet a number of the members of a family or of a community unite and obtain a sufficient area for engaging in the industry on a profitable scale. The annual product of that part of the bay situated in Maryland has averaged during the last six years about 135,000 bushels annually, at 90 cents per bushel clear.

The extent of the product varies much from season to season, and in 1887–88 and 1889–90 was more than twice the average, the product during each of the two seasons named being about 200,000 bushels at $1 per bushel. In 1891–92 the yield was 86,000 bushels, and in 1892–93 it was 105,600 bushels. These oysters usually go upon the markets as "Chincoteagues" or "Parker Bays."

There exists a regulation local to Worcester County in respect to the preëmption of planting areas that is, I believe, without a parallel in any part of the world. This regulation is in substance as follows: If through ignorance or mistake the locator of a planting lot should preëmpt a natural oyster-reef, the county commissioners are required, upon sworn information thereof being presented to them, to appoint three disinterested men to go with the locator, examine the lot, and report under oath relative to the same. If in the preëmpted area a reef more than 20 feet square in any one place be found they shall value the same and the locator shall pay the valuation to the county and also the expenses of the examining committee, the latter not to exceed $10; but if no reef more than 20 feet square be found the expenses of the committee shall be paid by the informer.

The utmost harmony, however, prevails among the oystermen of that region, and their operations are guided as much by public sentiment as by the statutes; hence no advantage has been taken of the opportunity here presented by collusion with one another for obtaining the natural reefs of that county.

In the Chesapeake region of Maryland, bedding is practiced more extensively in the Patuxent River than elsewhere. The "plants" are obtained from the public reefs in that river and are permitted to remain on the private areas for a few weeks or months, being deposited during a dull season and taken up when the oyster market is strong. Occasionally, however, they may remain on the private grounds for a year or more. The object in bedding is not so much to increase the size or condition of the oysters as to obtain a better market; and the expressions "storing" and "dumping," sometimes heard in the Chesapeake, express better than "bedding" the operations in this river. The quantity removed from these areas may approximate 100,000 bushels annually, but this is a product of the public reefs rather than of the planting lots.

While the preëmption of oyster-planting grounds in the Tangier and Pocomoke regions dates back to 1830, yet the bedding of oysters has never been vigorously or extensively conducted there, and what has been done was on an experimental rather than an industrial scale.

In Fishing Bay, on the southern shore of Dorchester County, the bedding has been of noticeable extent since 1871. The seed oysters, which are obtained from Tangier Sound and tributaries, cost from 10 to 20 cents per bushel and are permitted to remain one or two years. There is much complaint, however, that the risks from loss by unauthorized removal are very great, and there is little doubt that this practice has been of extreme detriment to an extension of the business.

Preëmptions were made in Somerset County as early as 1830, and occasionally oysters would be bedded on the areas located, but usually for only a few weeks. From 1870 to 1875 a number of persons were sufficiently interested in the subject of oyster-planting to attempt to make more extensive use of their lots, but little resulted from it. In 1884 and 1885 the subject was again revived in this county, and scores of lots were located. Those persons making use of their reservations planted the small oysters of Tangier Sound, costing, delivered on the beds, 10 or 15 cents per bushel, the size of the oysters ranging from that of a twenty-five-cent piece up to a silver dollar, but, being the "run of the rock," were mixed with considerable shells and débris. Col. T. S. Hodson, of Maryland, has furnished the following data in reference to these operations:

By October 1, 1885, the small oysters bedded in March of that year had become sufficiently large for shucking purposes, ranking as "straight-ups," with from one-fourth to one-third "selects" among them, worth 30 cents per bushel on the ground, while the quantity had increased threefold. Could they have remained another year, so as to acquire their full size, the profits to those who had planted them would have been very great. But an organization had been formed which determined to put an end to this new source of labor and profit. Some persons went in a body upon John H. Whealton's bed and began to take the oysters, but he opened on them with a shotgun, and the attempt soon ended. They took a few of the oysters bedded by James C. Nelson, who begged them to desist, which they soon did. A suit was instituted to vacate a certain lot as a natural oyster bed, on the ground that wherever scattering oysters could be found it was a natural bed. The court, however, found that there were less than 100 bushels on the 5 acres, and dismissed the suit.

As a consequence to the hostility thus exhibited, the planters determined to immediately realize on the oysters they had bedded, instead of waiting for a larger profit during the second season. They therefore hired men to take them up, paying 10 cents per bushel therefor, thus employing much labor that would otherwise have been idle Some of the planters did very well. Mr. Green took up 1,700 bushels in December, and sold them for 62 cents per bushel. Mr. James C. Nelson and Mr. R. N. Horsey, using a portion of 10 acres in Pocomoke Sound, have furnished the following statement of financial operations on that area in 1885–86:

Amount paid for 5,500 bushels seed oysters planted March, 1885, at 10 cents per bushel delivered	$550.00
Paid for taking up and marketing oysters in 1885–86	630.00
Total	1,180.00
Received from oysters sold in December, 1885	1,403.50
Received from oysters sold in spring, 1886	277.00
Total	1,680.50
Profit in 12 months=$500.50.	

After the oysters were sold in Crisfield, about $600 was paid for shucking them, and as all public-reef oysters obtainable were then being purchased to fill orders, this $600 was so much that the laboring class would never have received had these men not planted an oyster. Thus, from a little lot of $550 worth of oysters, the labor around Somerset County received for oysters planted, $550; for taking up oysters, $630; for shucking, etc., $600; total, $1,780. Since then fewer persons have planted oysters, and the majority of those have lost so heavily by depredations, during the daytime as well as at night, that they are almost discouraged.

An interesting attempt was made in 1890 by Messrs. C. A. DuBois & Co., oyster-dealers of Annapolis, to grow oysters on 10 acres of very muddy ground situated in the Severn River in Anne Arundel County, and during June of that year about 5,000 bushels of oyster shells were planted at a cost of $250. A set was obtained on these shells during the ensuing spawning season, and in the winter of 1891–92 about 3,000 bushels of oysters were taken from this area and marketed at 45 cents per bushel, and about 500 bushels were left on the bed to be removed later. In 1891, 5,000 bushels of shells and in 1892 10,000 bushels were planted on this area, but the set obtained was very poor.

The areas of ground situated within creeks less than 100 yards wide or within the lines of other property along the foreshores is exceedingly small, and the bedding of oysters in those areas is so insignificant in extent when compared with the extensive common oyster fishery of the State as to scarcely merit attention. A few such areas are situated in St. Mary and Calvert counties, and probably some in Talbot, Dorchester, and Somerset counties; but the quantity of oysters marketed from those private holdings scarcely exceeds 25,000 bushels annually, and nearly all of that was originally obtained from the public reefs.

It is thus observed that, except what is done in Dorchester County, even the simplest and most primitive modes of oyster-culture, the planting or bedding of small oysters, is an almost entirely undeveloped resource in Maryland; and in no sense of the word as used at present is the small bedding done in the Chesapeake a cultivation, and the expression "storing" or "dumping" well illustrates it. A farmer may as well plant his corn without first having prepared the ground and then without further care or attention or protection from birds or other animals expect to gather a harvest. He will be fortunate if able to gather as much corn as he planted, and so may the oysterman if able to take up as many oysters as he deposited.

Among the factors that have retarded the development of oyster-culture in this State might be mentioned the following: The area that a person is permitted to hold is so small that under the most favorable conditions the planter can afford to devote only a small portion of his time to it; the tenure is very uncertain and liable to be affected without notice by a change in the law or the administration thereof; the distinction between a natural reef and a barren bottom is so indefinite that after much attention has been paid to a lot, it is likely to be declared a natural reef, and as long as this condition of the ground is debatable planting thereon is an enterprise of great risk. It requires an investment of energy and labor to properly engage in oyster-culture, and these hesitate to touch the lots under the present impossibilities of enlargement and the insecurity of tenure. The uncertainty as to what are natural grounds has also encouraged certain persons to attempt to locate areas popularly supposed to come within that classification, in the hopes that under cover of the general sympathy being aroused in favor of the planters their scheme may prove successful.

What is desired is that the general assembly directly or indirectly determine specifically and precisely by metes and bounds what areas are open for location, permit the preëmption of sufficient area to justify a person in devoting his attention to it, and settle the tenure for a specified period of time.

But there is a trouble greater than all the foregoing factors combined, and that is the lack of protection to the oysters from being removed by persons refusing to recognize private ownership in bedded oysters. The lots are so small that they do not warrant the expense of the watchmen employed in other planting localities. Practically all the oysters may be removed from a lot in one night, and it is almost impossible to convict the offenders, it not being possible to identify the stolen goods. If apprehended and arrested and the removal of the oysters proven, a question then arises as to the location being a natural reef. But even if the offender be convicted, which is not usual, he is guilty only of a misdemeanor and may escape with a fine of from $20 to $200, while the value of the property obtained may have been many times that amount.

Confronted by these conditions, the oystermen who would otherwise engage in planting prefer to sell their small oysters for whatever they may bring rather than risk the uncertainties of harvesting a planted crop and endure the accompanying contentions with their neighbors.

The planting law of Worcester County is quite similar to that operative in the Chesapeake region. The area of preëmption is limited to 5 acres, the planters have no security of tenure, and they do not locate natural reefs. But there is this distinctive difference: the person unlawfully removing oysters from private areas in that county is guilty of felony, punishable with imprisonment in the penitentiary for from one to two years; and under the good influence of this provision, backed by a popular sentiment favorable to the planters, much of the bedding resources of the waters of that county are utilized, notwithstanding the small encouragement given by the general assembly.

The State as an oyster farmer.—The feeling is current among certain classes in Maryland that if the cultivation of oysters within the waters of that State be practicable the work should be undertaken by the State at large or by counties for the benefit either of the people of the State in general or of the counties respectively. Giving practice to this theory, a number of procedures have been authorized by the general assembly for improving the productiveness or increasing the area of the public beds.

The first attempt in this line was made in 1874 (ch. 77), when the county commissioners of Worcester County were authorized to expend all the revenue derived from the issuing of tonging licenses in that county in the purchase of seed oysters to be planted in the Sinepuxent Bay. The total amount of revenue derived from this source up to the present time has amounted to $4,690, but only a portion of it has been devoted directly to the purposes noted, and this mainly for planting small seed or the "run of the oyster rocks" during those years immediately following the enactment, the county commissioners being merely authorized and not required to purchase the seed oysters. During recent years few oysters or shells have been bedded on the public reefs by that county, the money being expended indirectly for the benefit of the oyster industry, as in cutting a canal, the building of necessary landing facilities, etc.

The revenue from this source is a sort of a contingent fund upon which to draw when special public expenditures are deemed necessary for the good of the oystermen.

By act of 1884 (ch. 255) the county commissioners of Somerset County were authorized (but not required) to utilize the revenue derived from the issuing of scraping licenses in that county to vessels measuring over 10 tons in the purchase and planting of shells on the public grounds within the county limits. The said commissioners were also empowered to make such regulations as might be necessary to protect the areas so improved; and it was further provided that "in case the general assembly shall provide for the sale or lease of oyster-grounds for the propagation of oysters the said county commissioners may buy or lease the said waters of said county for the use of the people thereof." This was a very ambitious undertaking, and except the very small operations in Sinepuxent Bay during those years immediately following 1874, as just noted, but which do not furnish a comparison, it was and is yet without a parallel in any part of the world—the annual expenditure of a large sum of public money in the cultivation of oysters on the public domain for the use of a common fishery. The sum available for this purpose then amounted to about $4,000 annually, but was rapidly increasing, and the area of the ground upon which operation was authorized approximated 180 square miles, covered with 60 square miles of oyster beds. The authority given the county commissioners at their discretion to permit or interdict oystering on the improved reefs is particularly noticeable, especially when it is considered that that is the principal oyster region of the greatest oyster-producing estuary in the world, and that in no other locality in America are the inherited privileges or customs of the common fishery more zealously guarded.

An effort was made by the county officials to properly enforce the intentions of the enactment. Quantities of shells were planted and a special police was provided for protecting the areas improved. But within a few months the county court expressed an *obiter dictum* that the provision for excluding the oystermen from those areas was not sufficiently explicit, and the police protection was withdrawn. At the next session of the general assembly (1886) the law was amended so as to meet the views expressed by the court; but in the meantime a change had been effected in the personnel of the county commissioners, and the new board, using their discretion in the matter as the law permitted, failed to exercise the authority given them. In 1888 the regulations, which had then been inoperative for three years, were repealed by the assembly.

By act of 1886 (ch. 314) an appropriation of $5,000 was made to be used by the commander of the State fishery force in the purchase and depositing of shells in May and June of that year in such places in the Chesapeake as that official might deem suitable for the purpose of obtaining thereon a "set" of oysters. For some cause the planting was delayed until the latter part of June, and as the spawning season was then almost over the undertaking was not a success. Indeed, had the shells been planted earlier the result might have been practically the same, for the set obtained in other portions of the bay during that year was not abundant. This was intended only as an experiment and not as the inauguration of a State policy. A similar experiment made by the State of Delaware in 1891, at an expense of $2,000, has, it is reported, resulted very satisfactorily.

TRANSPORTING.

History, etc.—The centering of the oyster trade for convenience of labor, shipment, etc., at Baltimore or other populous or railroad points, the location of the reefs many miles distant in the lower and tributary waters of the bay, and the necessary use of many small boats in the fishery, require the employment of a large number of vessels for transporting the catch from the reefs to the marketing-houses. As the State has exercised no supervision over these vessels, the data at hand for exhibiting the extent of this branch of the oyster industry are incomplete. As no license and no peculiar facilities other than those enjoyed by vessels engaged in general coasting trade are required, a number of vessels engage in transporting oysters for only a short time during the busy part of the season, and estimates are therefore likely to differ considerably.

In 1880 Mr. R. H. Edmonds, whose report has already been referred to, estimated that 200 vessels, employing 800 men, were engaged in transporting oysters in Maryland. But this was probably very much less than the actual number, as will be seen from the following incident: In 1884 (ch. 518) a law was enacted requiring all vessels engaged in transporting oysters to obtain a license on the same terms and conditions and at the same rate ($3 per ton) as was required of the vessels engaged in dredging, and a tax of 3 cents per barrel was imposed on all steamers carrying oysters while engaged in a regular freighting business. Of the transporting vessels 353, not engaged in dredging, paid the fees in order to continue the trade. A few vessels, however, opposed the payment of the tax, and their case being taken to the courts the law was declared unconstitutional, and the fees paid by other transporters, amounting to $27,644.15, were refunded. This indicates that there were about 400 transporting vessels during that season. The increasing number of market-houses at the ports down the bay and near the reefs, competing with and naturally decreasing the oyster trade of Baltimore, has during the last eight or ten years resulted in a corresponding decrease in the number of transporting vessels. But during the last three years the decreasing extent of the dredging industry, together with the large quantity of oysters taken by the tongmen and scrapemen, has resulted in an increase in the number of the transporting vessels. In 1889–90 the number was 351, the tonnage of which was 11,801.43. In 1890–91 this was increased to 399, with a tonnage of 13,111.45, and in 1891–92 it was further increased to 456, with a tonnage of 15,067.29, nearly equaling the tonnage employed in dredging.

The vessels.—The transporting vessels differ little from those employed in dredging. There are no very small craft among them, and their average measurement is much greater than that of the dredging vessels, the tonnage of the former being about 33.5 tons, and of the latter about 22 tons. The largest of the transporters are the *E. S. Johnson*, 85.7 tons, built in 1882, and the *Clemmie Traverse*, 81.05 tons, built in 1885. The average value of the transporting vessels is about $1,500; the original cost, however, was about twice that amount. During the summer the greater number of these vessels are engaged in transporting farm produce and general freight to and from various points along the shores of the bay and tributaries. The fluctuations from year to year in the number of vessels transporting oysters is to some extent governed by the prosperity of the dredging industry. If that branch of the oyster fishery gives indications of being profitable during a certain season, a large number of vessels obtain a license and engage in dredging; if the contrary be the case, the vessels are confined to transporting.

The men.—The men employed on the transporting vessels are usually residents of the State, and in most cases depend upon the freighting trade of the Chesapeake Bay for a living. The captain is usually on shares, and clears about $40 to $80 per month, while the laborers are on wages, receiving from $20 to $30 per month and board. The transporting vessels are successful in obtaining much better crews than the dredging vessels.

Profits and extent.—The captains of the transporting vessels purchase the oysters outright from the men catching them. The "buy boats" lie at anchor near the fishing fleet, with a basket at the masthead, or some other signal to indicate that oysters are being purchased, the latter being delivered as the oystermen finish their day's work. The profits made in transporting oysters are quite irregular, depending on the ability of the captains in striking a poor market "down the bay" and a good one in the city. During the cold weather in January, 1893, several vessels purchased oysters at 70 cents, and by paying heavy towage fees to Baltimore succeeded in obtaining $1.45 per bushel. But this was very exceptional, the gross profits throughout the season averaging 12 to 15 cents per bushel, an average for the fleet of about $900 per vessel.

The following table exhibits the extent to which vessels have engaged in transporting during certain recent seasons:

Years.	Vessels.			Outfit.	No. of men.	Gross profits *
	No.	Tonnage.	Value.			
1889-90	351	11,801.43	$536,135	$53,793	1,260	$356,000
1890-91	399	13,111.45	569,000	59,190	1,444	370,000
1891-92	456	15,067.29	653,235	72,290	1,651	400,000

* This represents the enhancement in value of the oysters transported.

Transporting trade with other States.—The preceding data relative to the transporting branch of the oyster industry do not include the large number of vessels owned elsewhere than in Maryland but engaging in transporting oysters from the waters of that State to other markets and to planting-grounds. From 1840 to 1870 this trade was very extensive, Cape Cod and Connecticut vessels being the principal ones interested, but vessels from Philadelphia, New York, and elsewhere were also employed. Barnstable and Wellfleet, Mass., alone had about fifty vessels engaged in this trade. They cost about $6,000, and carried about 2,500 bushels of oysters, four to eight voyages being made each spring. The transportation charges were about 15 cents per bushel, but during the civil war it went up to 25 cents. It is reported that one Cape Cod captain made 138 oyster trips to the Chesapeake before he was 40 years of age. This trade purchased oysters in Virginia as well as in Maryland.

These vessels now probably number sixty, averaging about 50 tons in measurement and $3,000 in value, with five men to each. They are usually employed but a few weeks in the spring, and the number is not half of what it was fifteen or twenty years ago, as the extensive development of private oyster beds in Northern States and the constantly increasing prices of the Chesapeake oysters are rendering their northern planting unsuccessful from a financial point of view.

Some of these transporting vessels go around Cape Charles, and the remaining pass through the Chesapeake and Delaware Canal. No reliable data are available to show the extent of the trade through the "capes," but by courtesy of Mr. T. J. Cleaver, collector of the Chesapeake and Delaware Canal Company, I am enabled to present the following tabular statement, exhibiting for a period of years the quantity of oysters passing through that canal:

Chesapeake and Delaware Canal, east-bound shipments.

Year.	Bushels.	Year.	Bushels.
1880	939, 600	1890	60, 340
1881	485, 385	1891	129, 660
1882	650, 100	1892	228, 055
1883	552, 227	1893	252, 428

About one half of these oysters pass through the canal during the last four or five weeks of the spring fishing. While a few of them go at once into the food markets, by far the greater portion are planted on the private grounds in Delaware Bay. Their average cost in Maryland probably does not exceed 25 cents per bushel, and at times it is very much lower than that, many vessels loading at 15 and 20 cents per bushel. After remaining planted in the Delaware Bay one or two years they are marketed at 75 cents to $1 per bushel. As oysters can not be safely transplanted during cold weather their movement is delayed until spring, and the date of the beginning of the close season determines largely the quantity transported for planting, this being very much greater before the adoption of the close season on tonging than at present.

Capt. Samuel M. Travers, formerly commander of the fishery force, submits the following as an exhibit of the quantity of oysters shipped North for planting purposes during the spring of 1879:

Shipped from—	Bushels.
Tangier Sound and tributaries	353, 750
Nanticoke River and Fishing Bay	125, 000
Little Choptank River	125, 000
Great Choptank River	375, 000
Eastern Bay	62, 500
Chester River	250, 000
Anne Arundel shore	112, 500
Patuxent River and tributaries	150, 000
Potomac River and tributaries	625, 000
Total	2, 178, 750

The average price paid is reported by him to have been 7 cents per bushel.

In 1880 the beginning of the close season was changed to April 15 so as to restrict this trade, with the result of reducing it during the ensuing season to about 1,000,000 bushels. One of the chief objects of the present close time in the spring is the restriction it places upon this transporting of seed oysters from the State.

1889–90 the Baltimore marketmen in the aggregate paid $20,000 to be relieved of the shells; in 1890–91 some paid to have the shells removed, some succeeded in giving them away, while others were enabled to sell, this depending on the storing facilities of the respective market-houses, and probably the trade came out even. In 1891–92 and 1892–93 nearly all the marketmen sold their shells at prices ranging from ½ to 1½ cents per bushel, the trade receiving each season about $25,000 therefrom. A similar condition prevailed at the smaller ports of the State.

The uses to which these shells are applied are numerous and constantly increasing, the principal ones being here enumerated in the order of their extent:

1. For country-road making and filling in hollows, chiefly in Maryland, but during the last three years the Southern States bordering the coast have used large quantities for this purpose.

2. For conversion into lime for use in coal-gas making and other purposes in Maryland and adjacent States.

3. In the cultivation of oysters, mostly in Virginia, but also in Connecticut and elsewhere. In 1891–92 and 1892–93 about 750,000 bushels were each year used in this manner. The Chesapeake oyster shells are not so desirable for "cultch" as those of New York and Connecticut, because of their being thicker and flatter.

4. For the beds of railroads. While not so endurable or steady as rock, yet they answer the purpose very well. Examples of their use in this manner may be found along the Baltimore and Eastern Shore railroad, the New York, Philadelphia and Norfolk railroad between Salisbury and King Creek, the Sparrow Point road, all in Maryland, and on the Southern Pacific railroad near Morgan City, La.

5. For chicken food. This product is very well known, the shells being merely crushed into small particles. Its popularity is increasing, but the quantity of shells utilized is small.

6. In the manufacture of certain special grades of iron. The shells are used because of their being so largely composed of carbonate of lime.

STATISTICAL SUMMARY.

Early extent of the industry.—Little reliable data exist with which to exhibit the extent of the oyster industry of Maryland prior to 1865. Careful search has been made through such Maryland publications of that time as would be likely to make reference to this subject, and although this search has not been rewarded with gratifying results the following data have been obtained.

An official report of the State, made in 1840, estimated the quantity of oysters used by the trade during the previous season at 710,000 bushels, the raw-shucking trade having been established in 1836; and in 1850 one of the daily papers of the State calculated that the annual consumption by the trade was then about 1,350,000 bushels, the steaming trade having been established four years previously.

A writer in the Baltimore American in 1857 stated that the quantity of oysters marketed in the shell during the preceding season, 1856–57, was 950,000 bushels, while the shucking-houses of the State utilized 1,660,000 bushels, a total of 2,610,000 bushels. The Merchants' Magazine and Commercial Review, of New York, estimated in 1859 the Maryland crop for the season 1858–59 to have been 3,500,000 bushels.

Lieut. Paul de Broca, who visited this country in 1862 to study the oyster industry in the interests of the French Government, reported the following as the extent of the Maryland industry in 1861:*

Maryland oyster fishery in 1861.

Bushels of oysters caught	3,000,000
Value of same	$1,050,000
Number of vessels and boats employed	500
Number of persons	3,000
Capital invested	$1,800,000
Commercial value of marketed products	$3,000,000

No data exist to verify or dispute any of these statements, and it is supposed that they fairly represent the extent of the industry during the periods for which they were respectively recorded.

Beginning with 1865, the record of the number of tonging, dredging, and scraping licenses issued, as exhibited on other pages of this report, is a good index to the growth and prosperity of each branch of the fishery. The data relative to the quantity of oysters obtained since then are also more voluminous and reliable than for the preceding period.

During the first season in which the general license system was operative, 1865–66, according to Mr. C. S. Maltby, the catch by tongs amounted to 1,216,375 bushels and by dredges and scrapes 3,663,125, a total of 4,879,500 bushels.

For the seasons 1868–69, 1869–70, and 1870–71 the following statistics have been presented by Mr. Hunter Davidson, who was then in command of the fishery force:

Maryland oyster fishery in 1868–69, 1869–70, and 1870–71.

Items.	1868–69.	1869–70.	1870–71.
Vessels dredging and scraping:			
Number	563	642	637
Tonnage	12,660	14,436	14,425
Value	$449,400	$513,600	$509,600
Boats tonging:			
Number	1,907	1,647	1,709
Value	$143,025	$123,525	$134,400
Men dredging and scraping	3,560	4,060	3,775
Men tonging	3,325	3,410	3,807
Catch, dredging and scraping ... bushels	6,305,600	7,190,400	6,686,400
Catch, tonging	1,735,370	2,043,075	2,261,403
Total ... bushels	8,040,970	9,233,475	8,947,803
Value	$2,814,340	$3,231,716	$3,031,731

The following data were reported in 1880 by the U. S. Fish Commission, as representing the extent of the industry in 1879–80:

Maryland oyster fishery in 1879–80.

Branches of the industry.	No of boats and vessels.	Value of boats and vessels.	No of persons employed.
Dredging	700	$1,050,000	5,600
Scraping	550	440,000	2,200
Tonging	1,825	182,500	5,148
Transporting	200	300,000	800
Total	3,275	1,972,500	13,748

Oysters caught, number of bushels 10,600,000.

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*Étude sur l'Industrie Huitrière des États-Unis. Paris, 1865.

During the last eight years the largest quantity received at Baltimore during any one week was 408,940 bushels, which arrived during the week ending November 17, 1888. The smallest quantity during the busy part of the season for the same period was 20,110 bushels, in the week ending January 21, 1893. The receipts from the 19th to the 25th week were very much less in 1892–93 than for the same period of time for many years, this being due to the exceptionally cold weather restricting the catch, thousands of boats and vessels being "frozen up." Had the receipts during those weeks been equal to those of the corresponding period in the previous season the quantity landed at this port during 1892–93 would have exceeded that of 1891–92 by over 1,000,000 bushels.

The commission sellers.—Practically all the oysters delivered at Baltimore in bulk are handled by men known as commission sellers, who control the sales of nearly all the oyster vessels arriving in that port, and most of whom have been oystermen at some time in their careers. They attend to the financial dealings of the captains in the city, the bargaining and sale of the oysters, and advance money to the oystermen when desired. For their services they charge 1½ cents per bushel, but prior to the season 1891–92 they received 1 cent per bushel of oysters handled. They usually work in companies of 2 or 3 men each, the number of companies being 15, consisting of 34 men and using property valued at $65,000, with cash or credit capital approximating $260,000. By these men the oysters are sold to the various branches of the trade.

Raw-shucking trade.—During the early prosecution of the oyster industry such oysters as were landed at Baltimore and not needed or intended for local consumption were sent by wagons and cars to the neighboring towns in the shell. The first wholesale shucking-house was opened here about 1830, but met with indifferent success and soon abandoned the business. At that time the oyster trade of the country centered about New York City and Fair Haven, Conn., particularly the latter place, at which were marketed native Connecticut oysters as well as the stock obtained by vessels from the Chesapeake. The continued decrease in the native supply in that State, and the consequent increase in cost, indicated that the trade could be more profitably carried on in Baltimore than in Fair Haven, and induced Mr. C. S. Maltby of the latter place to move to Baltimore in 1836 and establish a shucking-house on the plan of those operating in his native town. His trade increased rapidly and, the success being noted, other persons engaged in the business, and within a few years regular lines of oyster wagons were operated, running from Baltimore to the neighboring cities. Those oysters intended for shipment to distant points were shucked and sealed in tin cans or very small wooden kegs, and with care could be preserved for a few weeks, this depending on their temperature. The general use of these small packages, however, was long ago discontinued, and the shipment is now almost entirely in large tubs or kegs holding several gallons.

It is reported that in 1846–47 there were six houses in this trade, utilizing about 250,000 bushels annually. In 1865–66 the oysters utilized in the raw-shucking trade amounted to 1,875,000 bushels. From that time until 1874 the trade rapidly increased in extent, but since the last-named date, on account of the increasing competition with other markets along the bay shores, little variation has existed in the quantity of oysters handled by this branch of the trade at Baltimore. The following table shows the quantity utilized in the raw-shucking trade of that city during a number of seasons.

Baltimore raw-shucking trade receipts.

Season.	No. of bushels.	Season.	No. of bushels.
1846–47	250, 000	1887–88	2, 893, 755
1865–66	1, 875, 000	1888–89	2, 809, 120
1879–80	3, 769, 353	1889–90	3, 206, 177
1884–85	3, 255, 095	1890–91	2, 331, 228
1885–86	3, 549, 873	1891–92	2, 736, 342
1886–87	2, 975, 385	1892–93	2, 698, 126

At present the number of Baltimore houses engaged in shucking oysters for the raw trade is 58, with property valued at $1,330,000; 10 of these houses, worth $615,000, engage also in handling steamed oysters. One or two of them with the wharf property attached are worth $175,000 and are capable of handling 7,000 bushels of oysters in a day. The number of persons employed in the raw trade is about 3,650, of whom about 3,200 are engaged in shucking. The latter are mostly men, but in some of the establishments large numbers of women find employment. The work is fatiguing and requires strength as well as skill. The men are usually able to shuck more than the women; and while an able male shucker working 12 hours can make $2.25 per day, yet because of the irregular employment the shuckers do not average more than $1.25 throughout the season. The price paid for this labor is 20 cents per "gallon cup," this, as provided by the statutes (L. 1886, ch. 537), holding 9 pints wine measure. The other employés in the raw-shucking trade, numbering about 450 men, are on weekly wages, ranging from $6 to $20 per week, and amounting to about $115,000 during an average season.

In addition to labor items, large expenditures are made for ice, tubs, etc., making the total cost of handling the oysters in the shucking houses about 25 cents per bushel. The total value of the output of the raw-shucking houses of Baltimore during each of the last four seasons has been $2,662,076, $2,373,526, $2,482,000, and $2,625,000, or an average for each bushel of oysters received of $0.83, $1.02, $0.90, and $0.97, respectively.

The steaming trade.—The preserving of prepared foods in hermetically sealed tin cans was begun in this country about 1844, salmon and lobsters being among the first products so prepared. About 1848 a modification of the process employed was extended to the preserving of oysters, they being first cooked in kettles. This is said to have been originated by Mr. Thomas Kensett, of Baltimore, but the trade was developed by Messrs. A. Field & Co., of that city. About 1860 Mr. Lew McMurry began scalding the oysters, and the product of his house enjoyed a high reputation.*

The present method of steaming began about 1864, the procedure then adopted differing from the present in that the oysters were placed in baskets holding about 3 pecks each, and these to the number of about 200 were placed in a large box and there steamed. From the beginning of this trade up to the present time it has been prosecuted almost entirely at Baltimore, probably not 5 per cent of the total quantity of oysters steam-canned in America since 1848 having been prepared in houses outside of that city. From 1860 up to 1875 the steaming business was prosperous, but from 1875 to 1880 reputable firms engaged in this branch of the oyster industry suffered considerably from the operations of certain unscrupulous packers, who by putting up "light weights" injured the reputation of the Baltimore product. Mutual coöperation among the packers resulted in a decrease in the fraudulent practice, but it was not entirely broken up until 1884, when the general assembly required (L. 1884, ch. 257) that all persons engaged in steaming oysters should cause to be stamped on each can the true weight of the solid oysters therein, all sales of unstamped oysters to be void. Provision was made for the appointment by the governor of two persons as examiners of the oysters packed, who should see that the law relative to "light weights" was properly enforced. Each person or company engaging in the canning of steamed oysters, as a condition on which they were permitted to carry on the business, was required, at the end of each month, to make a sworn statement to the comptroller of the State treasury of the quantity of oysters steamed, at the same time paying into the State treasury one-tenth of 1 cent per bushel for all so used.

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* In 1852 a canning house was started by Messrs. Piper and Stetson near Stockton, in Worcester county, but closed after working a few months.

The following statement is presented exhibiting for a period of years the quantity of oysters utilized in the steaming trade at Baltimore:

Baltimore steaming trade receipts.

Season.	No. of bushels.	Season.	No. of bushels.
1865-66	965,000	1888-89	2,570,217
1879-80	2,689,939	1889-90	2,491,088
1884-85	2,745,923	1890-91	1,860,792
1885-86	3,074,770	1891-92	2,396,763
1886-87	2,909,761	1892-93	1,826,428
1887-88	2,591,402		

The number of houses in Baltimore engaged in steaming oysters is 20, valued at $1,255,000; of these, 10 valued at $630,000 engage in handling raw oysters as well as steamed. These houses are all located along the shores of the harbor, and, together with the ground occupied, range in value from $6,000 to $185,000. The quantity of oysters handled by each house varies from a few hundred bushels to 650,000. The smallest quantity handled by any one house in 1889-90 was 631 bushels; in 1890-91, 3,866 bushels; in 1891-92, 7,918 bushels; and in 1892-93, 2,014 bushels. The largest quantity handled by any one house during the same seasons was 551,771, 560,815, 557,984, and 505,100, respectively. On several occasions a single house has steamed over 170,000 bushels in one month.

The following table exhibits by months the quantity of oysters steam-canned at Baltimore during certain seasons:

Months.	1884-85.	1885-86.	1889-90.	1890-91.	1891-92.	1892-93.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
September	61,623	67,281	....	20,524	6,244	10,677
October	268,180	564,023	354,241	207,436	390,257	490,608
November	474,826	769,265	549,817	396,728	586,370	348,395
December	485,062	516,052	299,218	307,183	459,460	178,830
January	255,424	129,004	141,459	165,312	83,005	14,042
February	274,921	247,289	301,352	308,709	290,980	39,134
March	543,523	575,364	385,996	157,329	269,372	346,910
April	382,364	206,492	457,820	295,203	311,075	397,832
May	....	....	1,185	2,368	....	....
Total	2,745,923	3,074,770	2,491,088	1,860,792	2,396,763	1,826,428

The following is a description of the methods employed in steaming-houses:

The oysters are taken from the vessels and placed in cars of iron frame-work, 6 or 8 feet long. These cars run on a light iron track, which is laid from the wharf through the "steam chest" or

The total extent to which Maryland is dependent on the oyster fishery is not fully indicated in the foregoing tables. The amount of money received by the oystermen for their product poorly represents the value of this industry. In the eleven counties in which the fishery is prosecuted it is the mainstay of the people, and the prosperity of nearly all business therein is regulated by it. As four-fifths of the oysters are sent out of the State through wholesale markets, etc., and as the value of the product after it has passed through these markets and transportation agencies averages about 90 cents for each bushel originally represented, it is reasonable to assume that for each bushel of oysters caught in Maryland about 70 cents is brought into the State. During the last ten years this would amount to about $80,000,000 received by the oystermen, marketmen, transportation agencies, etc., which would not have been brought into the State were it not for the oyster fishery, and this does not include the value of the millions of bushels of oysters consumed within the State. This sum is much greater than the total taxable value of all property located in the counties in which this fishery is prosecuted, not including the city of Baltimore.

At least 95 per cent of this revenue is received by men whose wages or incomes amount to less than $1,000 a year. In this class are included all the oystermen and nearly all the employés of the shucking-houses and transportation agencies. Then, when consideration is taken of the large number of persons engaged in other vocations, but dependent on the patronage of these men to a greater or less extent, such as vessel builders and repairers, sail-makers, blacksmiths, house carpenters, groceryman, merchants, even the physicians, lawyers, etc., the enormous value of the industry is apparent, and it is observed how vitally important to the people of the State is the continued prosperity of the fishery.

A careful survey of the extent of the oyster product of Maryland from the beginning of the present century develops the following as an approximation of the product during each decade, not including those taken by non-residents or those used for fertilizing purposes:

Period.	No. of bushels.	Period.	No. of bushels.
1800–1810	2,500,000	1860–1870	63,000,000
1810–1820	4,000,000	1870–1880	114,000,000
1820–1830	5,000,000	1880–1890	116,000,000
1830–1840	8,000,000	1890–1893	31,720,000
1840–1850	15,000,000		
1850–1860	34,000,000	Total	393,220,000

To exhibit the comparative value of this product, the following tabular statement is submitted showing the average prices received at Baltimore during the seasons indicated for "straight up" or standard stock. These figures are a trifle higher than the average for the product of the State:

Season.	Average price per bushel.	Season.	Average price per bushel.
	Cents.		*Cents.*
1850–51	30	1880–81	40
1855–56	30	1885–86	45
1860–61	25	1889–90	56
1865–66	*70	1890–91	60
1870–71	25	1891–92	62
1875–76	24	1892–93	66

*War prices.

cans, which contain about 5 ounces of solid meats, the 2-pound cans containing 10 ounces. The price received during the last four or five years for the 1-pound and 2-pound cans has averaged about 85 cents and $1.60, respectively, per dozen. The value of the output of the canning trade during each of the last four seasons has been $1,728,985, $1,612,572, $1,856,510, and $1,505,940, an average for each bushel of oysters handled of about 69, 86, 77, and 84 cents, respectively. During the summer these houses and employés are also engaged in canning fruits and vegetables.

Through the valuable assistance of many persons connected with the oyster trade of Baltimore, I am enabled to exhibit, with much detail, the extent of the trade in that city during recent seasons, these data being presented in the following table:

Statistics of Baltimore oyster trade.

Items.	1889-90.	1890-91.	1891-92.
No. of establishments:			
Raw trade only	51	49	48
Raw and steaming trade combined	9	9	10
Steaming trade only	10	10	10
Commission sellers	14	15	15
Total	84	83	83
Property invested, value:			
Raw trade only	$734,600	$715,500	$715,000
Raw and steaming trade combined	610,000	595,000	615,000
Steaming trade only	645,000	639,000	640,000
Commission sellers	55,000	63,600	65,000
Total	2,044,600	2,013,100	2,035,000
Cash or credit capital:			
Raw trade	$650,000	$570,000	$620,000
Steaming trade	1,045,000	930,000	1,170,000
Commission sellers	240,000	255,000	260,000
Total	1,935,000	1,755,000	2,050,000
Persons engaged (proprietors and clerks):			
Raw trade only	139	130	132
Raw and steaming trade combined	42	42	44
Steaming trade only	46	46	47
Commission sellers	40	43	43
Total	267	261	266
Shuckers:			
Raw trade	3,284	3,014	3,194
Steaming trade	4,256	3,763	4,203
Total	7,540	6,777	7,397
Other employés:			
Raw trade	320	278	306
Steaming trade	560	514	554
Total	880	792	860
Grand total of persons	8,687	7,830	8,523
Trade of commission sellers:			
Oysters rec'd from transporters, bush.	5,925,400	4,393,600	5,354,320
Value received by transporters	$3,084,075	$2,967,051	$3,108,390
Value received by commission sellers	3,143,329	3,010,987	3,188,650

Items.	1889-90.	1890-91.	1891-92.
Raw-shucking trade:			
Oysters rec'd, bush.	3,206,177	2,331,228	2,736,342
Expenses:			
Cost of oysters	$1,899,660	$1,806,129	$1,810,120
Wages paid to shuckers	425,909	302,164	366,430
Wages paid to others	128,247	89,752	109,365
Incidental expenses	67,330	45,760	60,000
Total	2,521,146	2,243,805	2,345,915
Products:			
Extra selects—			
Gallons	83,361	48,475	52,120
Value	$134,062	$82,184	$75,180
Selects—			
Gallons	589,724	452,266	520,610
Value	$768,260	$682,287	$724,050
Standards—			
Gallons	1,947,636	1,362,640	1,654,350
Value	$1,759,754	$1,608,055	$1,682,770
Total gallons	2,620,721	1,863,381	2,227,080
Total value	$2,662,076	$2,373,526	$2,482,000
Steaming trade:			
Oysters rec'd, bush.	2,491,088	1,860,792	2,396,763
Expenses:			
Cost of oysters	$1,071,168	$1,023,436	$1,201,600
Wages paid to shuckers	74,320	61,074	73,680
Wages paid to others	98,765	74,160	97,500
Cost of tin cans, labels, etc	319,022	310,370	320,000
Incidental expenses	24,950	18,900	25,000
Total	1,588,225	1,487,940	1,717,780
Products:			
5-ounce cans, prepared—			
Number	9,569,160	7,890,632	9,388,650
Value	$723,027	$632,741	$764,450
10-ounce cans prepared—			
Number	4,579,356	3,995,521	4,643,822
Value	$632,138	$621,146	$725,515
Miscellaneous cans, prepared—			
Ounces	23,361,850	19,720,840	22,635,000
Value	$373,820	$358,685	$366,545
Total ounces	117,001,210	99,129,210	116,016,470
Total value	$1,728,985	$1,612,572	$1,856,510

of the natural reefs on which these three forms of fishery are prosecuted has been found to be about 154, 121, and 80 square miles, respectively, and the average annual product during the last five years, 4,850,000, 3,450,000, and 2,750,000 bushels. These data form the basis of the following tabular statement:

Form of fishery.	Area, square miles.	Product, bushels.	Annual revenue, average for five years.	Average revenue.	
				Per square mile.	Per 1,000 bushels.
Tonging	154	4,850,000	$21,947.50	$142.51	$4.52
Dredging	*121	3,450,000	50,135.09	414.33	14.53
Scraping	80	2,750,000	12,198.67	152.48	4.43
Total	355	11,050,000	84,281.26		
Average				237.41	7.62

* Of this area 42 square miles are used also by Virginia oystermen.

The foregoing table exhibits the annual average rate of revenue for the last five years, but as the license fees for tonging were increased in 1892 it does not properly exhibit the extent of the tax which that branch of the fishery is now paying, and the following table is submitted for this purpose, showing the condition of the license-revenue receipts for the season 1892–93:

License-revenue receipts for 1892–93.

Form of fishery.	Area, square miles.	Product, bushels.	Annual revenue.	Average revenue.	
				Per square mile.	Per 1,000 bushels.
Tonging	154	4,432,500	$32,353.50	$210.09	$7.30
Dredging	121	3,100,000	44,781.72	370.14	14.44
Scraping	80	2,610,000	13,333.74	166.67	5.10
Total	355	10,142,500	90,468.96		
Average				254.84	8.92

The fact that about 200 vessels and boats work under both a dredging and a scraping license complicates somewhat the consideration of the proportionate revenue per square mile or per 1,000 bushels for those two forms of fishing. In the two foregoing tables the catch made by these craft has been noted entirely under dredging. Were it practicable to exhibit with greater accuracy these average items for the two branches of fishery indicated the average revenue from dredging per square mile would be slightly decreased and the revenue per 1,000 bushels would be slightly increased and an opposite effect would be produced in these two items for the scraping branch of the fishery, but the change effected would not be material.

It is thus observed that during the last season the dredgers have paid twice as much revenue or tax per 1,000 bushels as the tongmen and nearly three times as much as the scrapemen. The total revenue during that season averaged $8.92 per 1,000 bushels, or $254.84 per square mile, or 40 cents per acre. As the oystermen received about $5,500,000 for their catch, the State revenue was at the rate of over $16 per $1,000 worth of oysters.

The total revenue since the adoption of the license system being $1,781,520.61, and the area of the reefs approximating 355 square miles, the State has up to the houses, valued at $50,000, and employing 700 persons, who receive nearly $100,000 in wages annually. The quantity of oysters handled by these houses approximates 650,000 bushels annually and consists mostly of "Choptanks" and "Eastern Bays."

Anne Arundel County.—Excepting Baltimore, Annapolis is the only wholesale oyster market on the Western Shore of Maryland. The business was established here about 1866 and, together with the oyster fishery, at present constitutes the most important commercial source of revenue in the "Ancient City." Nearly all of the oysters handled are the product of the tonging-grounds along the shores of Anne Arundel County, with occasional cargoes from Eastern Bay and Chester River. The quantity received at this market annually amounts to about 300,000 bushels, and the persons employed in the 10 houses, which are valued at $35,000, number 400, who receive $40,000 a year in wages, the cost of handling the oysters being about $75,000.

Other ports.—Several small markets exist in Wicomico and Queen Anne counties, giving employment to about 125 persons and utilizing about 110,000 bushels of oysters annually. The shucking-houses in Wicomico County are located at Whitehaven, on the Wicomico River. Salisbury, in that county, formerly handled a large quantity of oysters and was the first wholesale market established in Maryland outside of Baltimore, but the more favorable location of Crisfield attracted the trade of Salisbury as soon as the former port obtained railroad facilities.

The oyster trade at Seaford, Delaware, located on a branch of the Nanticoke River, is entirely dependent on the product of the fishery in Maryland, nearly all of its supply being obtained from the Tangier Sound and tributaries. This was the first of the down-the-bay oyster markets, the industry being started here in 1859 by Messrs. Platt and Mallory, from Connecticut. From 1860 to 1868 a large business was done in canning raw oysters. At present there are 5 shucking-houses at Seaford, valued at $10,000, employing 415 persons, and handling about 250,000 bushels of oysters annually.

The following tables exhibit with much detail the extent of the shucking trade at the county markets during certain seasons:

The county oyster markets.

1889-90.

Counties.	Number of firms.	Number of persons engaged.	Value of property.	Cash or credit capital.	Wages paid.	Oysters received.		Oysters sold.		Enhancement in value.	Average cost per bushel.	Average value received per bushel.	Average enhancement in value per bushel.
						Bushels.	Value paid.	Gallons.	Value received.				
Somerset	27	1,436	$115,750	$112,950	$165,886	1,140,753	$513,138	771,558	$780,376	$267,238	$0.45	$0.68	$0.23
Wicomico	1	63	3,300	5,000	4,925	46,500	20,925	31,500	33,560	12,635	.45	.72	.27
Dorchester	18	789	49,430	76,500	94,440	674,200	303,390	451,254	456,558	153,168	.45	.68	.23
Talbot	14	716	47,975	37,200	102,976	709,970	333,925	484,595	505,976	172,051	.47	.71	.24
Queen Anne	2	37	1,750	1,300	5,310	35,000	14,500	23,700	23,751	9,251	.41	.67	.26
Anne Arundel	10	403	34,500	40,000	56,500	387,941	139,690	271,620	231,880	92,190	.36	.60	.24
Total	72	3,444	252,705	272,950	430,037	2,994,364	1,325,558	2,034,227	2,032,081	706,523	.44	.67	.24

1890-91.

Counties.	Number of firms.	Number of persons engaged.	Value of property.	Cash or credit capital.	Wages paid.	Oysters received.		Oysters sold.		Enhancement in value.	Average cost per bushel.	Average value received per bushel.	Average enhancement in value per bushel.
						Bushels.	Value paid.	Gallons.	Value received.				
Somerset	28	1,543	119,075	123,250	181,675	1,259,040	570,969	848,208	854,034	283,065	.46	.68	.22
Wicomico	2	123	8,900	11,500	11,633	110,500	55,250	74,850	77,690	22,440	.50	.70	.20
Dorchester	19	745	80,650	75,100	83,910	583,788	294,526	398,935	407,954	113,428	.50	.70	.20
Talbot	13	632	49,450	35,200	80,735	562,448	277,297	392,170	386,892	109,595	.49	.69	.20
Queen Anne	2	32	1,730	1,300	5,050	33,000	16,500	22,400	22,530	6,030	.50	.69	.19
Anne Arundel	9	398	33,000	39,500	34,800	261,528	136,240	201,064	167,910	31,670	.50	.70	.20
Total	73	3,463	292,825	285,850	397,803	2,810,202	1,350,782	1,927,725	1,917,010	566,218	.48	.69	.20

The following tabular statement exhibits in a comparative form the total extent of the shucking trade during a number of seasons. The increase in the county markets at the expense of the trade at Baltimore is particularly noticeable:

Table showing total extent of the oyster-shucking trade in Maryland.

Items.	1879–80.			1889–90.		
	Baltimore.	Counties.	Total.	Baltimore.	Counties.	Total.
Number of persons	6, 627	2, 012	8, 639	8, 687	3, 444	12, 131
Value of property	$1, 360, 966	$75, 060	$1, 436, 026	$2, 044, 600	$252, 705	$2, 297, 305
Cash capital	$2, 338, 300	$154, 050	$2, 497, 350	$1, 935, 000	$272, 950	$2, 207, 950
Wages paid	$602, 427	$175, 352	$777, 779	$727, 241	$430, 037	$1, 157, 278
Other expenses	$497, 541	$126, 190	$523, 731	$411, 302	....	....
Oysters shucked:						
Raw, bushel	3, 769, 353	1, 160, 948	4, 930, 301	3, 206, 177	2, 994, 364	6, 200, 541
Value paid	$1, 448, 040	$300, 420	$1, 748, 460	$1, 899. 660	$1, 325, 558	$3, 225, 218
Value received	$2, 272, 240	$453, 497	$2, 725, 737	$2, 662, 076	$2. 032, 081	$4, 694, 157
Oysters canned:						
Bushels	2, 689, 939	33, 252	2, 723, 191	2, 491, 088	....	2, 491, 088
Value paid	$811, 208	$7, 280	$818, 488	$1, 071, 168	....	$1, 071, 168
Value received	$1, 244, 609	$23, 403	$1, 268, 112	$1, 728, 985	....	$1, 728, 985
Total oysters handled:						
Bushels	6, 459, 292	1, 194, 200	7, 653, 492	5, 697, 265	2, 994, 364	8, 691, 629
Value paid	$2, 259, 248	$307, 600	$2, 566, 848	$2, 970, 828	$1, 825, 558	$4, 296, 386
Value received	$3, 517, 349	$476, 499	$3. 993, 848	$4, 391, 061	$2, 032, 081	$6, 423, 142
Enhancement in value	$1, 258, 101	$168, 899	$1, 427, 000	$1, 420, 233	$706, 523	$2, 126, 756

Items.	1890–91.			1891–92.		
	Baltimore.	Counties.	Total.	Baltimore.	Counties.	Total.
Number of persons	7, 830	3, 463	11, 293	8, 523	3, 585	12, 108
Value of property	$2, 013, 100	$262. 525	$2, 275, 625	$2, 035, 000	$270, 500	$2, 305, 500
Cash capital	$1, 755, 000	$285, 850	$2, 040, 850	$2, 050, 000	$295, 000	$2, 245, 000
Wages paid	$527, 150	$397, 803	$924, 953	$646, 975	$456, 350	$1, 103, 325
Other expenses	$375, 030	....	....	$405, 000	....	....
Oysters shucked:						
Raw, bushel	2, 331, 228	2, 810, 292	5, 141, 520	2, 736, 342	3, 362, 480	6, 098, 822
Value paid	$1, 806, 129	$1, 350, 782	$3, 156, 911	$1, 810, 120	$1, 544, 610	$3, 354, 730
Value received	$2, 373, 526	$1, 917, 000	$4, 290, 526	2, 482, 000	$2, 368, 130	$4, 850, 130
Oysters canned:						
Bushels	1, 860, 792	....	1, 860, 792	2, 396, 763	....	2, 396, 763
Value paid	$1, 023, 436	....	$1, 023, 436	$1, 201, 600	....	$1, 201, 600
Value received	$1, 612, 572	....	$1, 612, 572	$1, 856, 510	....	$1, 856, 510
Total oysters handled:						
Bushels	4, 192, 020	2, 810, 292	7, 002, 312	5, 133, 105	3, 362, 480	8, 495, 585
Value paid	$2, 829, 565	$1, 350, 782	$4, 180, 347	$3, 011, 720	$1, 544, 610	$4, 556, 330
Value received	$3, 986, 101	$1, 917, 000	$5, 903, 101	$4, 338, 000	$2, 368, 130	$6, 706, 130
Enhancement in value	$1, 156, 536	$566, 218	$1, 722, 754	$1, 326, 280	$823, 520	$2, 149, 800

The oyster shells.—The disposition of the shells has always been an important item for consideration in connection with the marketing of oysters. As several hundred vessels are constantly employed during seven months of each year in transporting oysters to the markets, and as 1,000 bushels of oysters produce about 1,100 bushels of shells, it can be imagined how rapidly these accumulate about the shucking-houses. The quantity of shells landed on the Maryland shores during the last ninety years approximates nearly 400,000,000 bushels, or 12,000,000 tons, twice sufficient to overload and sink every sail and steam vessel and barge and canal boat of America, and greater than the combined tonnage of all the sail vessels of the world. As three-fourths of the composition of the shell is carbonate of lime, the question that the Fool asked of King Lear—how the oyster makes its shell—appears almost unanswerable.

Until the last two or three years the shells were usually given away without cost to the recipient and even then it was so difficult to become relieved of them that those marketmen with very limited areas attached to their shucking-houses spent thousands of dollars annually in having the shells removed. But the demand for them so greatly increased that they are now a considerable source of profit. It is estimated that in

1889–90 the Baltimore marketmen in the aggregate paid $20,000 to be relieved of the shells; in 1890–91 some paid to have the shells removed, some succeeded in giving them away, while others were enabled to sell, this depending on the storing facilities of the respective market-houses, and probably the trade came out even. In 1891–92 and 1892–93 nearly all the marketmen sold their shells at prices ranging from ½ to 1½ cents per bushel, the trade receiving each season about $25,000 therefrom. A similar condition prevailed at the smaller ports of the State.

The uses to which these shells are applied are numerous and constantly increasing, the principal ones being here enumerated in the order of their extent:

1. For country-road making and filling in hollows, chiefly in Maryland, but during the last three years the Southern States bordering the coast have used large quantities for this purpose.

2. For conversion into lime for use in coal-gas making and other purposes in Maryland and adjacent States.

3. In the cultivation of oysters, mostly in Virginia, but also in Connecticut and elsewhere. In 1891–92 and 1892–93 about 750,000 bushels were each year used in this manner. The Chesapeake oyster shells are not so desirable for "cultch" as those of New York and Connecticut, because of their being thicker and flatter.

4. For the beds of railroads. While not so endurable or steady as rock, yet they answer the purpose very well. Examples of their use in this manner may be found along the Baltimore and Eastern Shore railroad, the New York, Philadelphia and Norfolk railroad between Salisbury and King Creek, the Sparrow Point road, all in Maryland, and on the Southern Pacific railroad near Morgan City, La.

5. For chicken food. This product is very well known, the shells being merely crushed into small particles. Its popularity is increasing, but the quantity of shells utilized is small.

6. In the manufacture of certain special grades of iron. The shells are used because of their being so largely composed of carbonate of lime.

STATISTICAL SUMMARY.

Early extent of the industry.—Little reliable data exist with which to exhibit the extent of the oyster industry of Maryland prior to 1865. Careful search has been made through such Maryland publications of that time as would be likely to make reference to this subject, and although this search has not been rewarded with gratifying results the following data have been obtained.

An official report of the State, made in 1840, estimated the quantity of oysters used by the trade during the previous season at 710,000 bushels, the raw-shucking trade having been established in 1836; and in 1850 one of the daily papers of the State calculated that the annual consumption by the trade was then about 1,350,000 bushels, the steaming trade having been established four years previously.

A writer in the Baltimore American in 1857 stated that the quantity of oysters marketed in the shell during the preceding season, 1856–57, was 950,000 bushels, while the shucking-houses of the State utilized 1,660,000 bushels, a total of 2,610,000 bushels. The Merchants' Magazine and Commercial Review, of New York, estimated in 1859 the Maryland crop for the season 1858–59 to have been 3,500,000 bushels.

Lieut. Paul de Broca, who visited this country in 1862 to study the oyster industry in the interests of the French Government, reported the following as the extent of the Maryland industry in 1861:*

Maryland oyster fishery in 1861.

Bushels of oysters caught	3,000,000
Value of same	$1,050,000
Number of vessels and boats employed	500
Number of persons	3,000
Capital invested	$1,800,000
Commercial value of marketed products	$3,000,000

No data exist to verify or dispute any of these statements, and it is supposed that they fairly represent the extent of the industry during the periods for which they were respectively recorded.

Beginning with 1865, the record of the number of tonging, dredging, and scraping licenses issued, as exhibited on other pages of this report, is a good index to the growth and prosperity of each branch of the fishery. The data relative to the quantity of oysters obtained since then are also more voluminous and reliable than for the preceding period.

During the first season in which the general license system was operative, 1865–66, according to Mr. C. S. Maltby, the catch by tongs amounted to 1,216,375 bushels and by dredges and scrapes 3,663,125, a total of 4,879,500 bushels.

For the seasons 1868–69, 1869–70, and 1870–71 the following statistics have been presented by Mr. Hunter Davidson, who was then in command of the fishery force:

Maryland oyster fishery in 1868–69, 1869–70, and 1870–71.

Items.	1868–69.	1869–70.	1870–71.
Vessels dredging and scraping:			
Number	563	642	637
Tonnage	12,660	14,436	14,425
Value	$449,400	$513,600	$509,600
Boats tonging:			
Number	1,907	1,647	1,792
Value	$143,025	$123,525	$134,400
Men dredging and scraping	3,560	4,060	3,775
Men tonging	3,325	3,410	3,807
Catch, dredging and scraping ... bushels	6,305,600	7,190,400	6,686,400
Catch, tonging	1,735,370	2,043,075	2,261,403
Total ... bushels	8,040,970	9,233,475	8,947,803
Value	$2,814,340	$3,231,716	$3,031,731

The following data were reported in 1880 by the U. S. Fish Commission, as representing the extent of the industry in 1879–80:

Maryland oyster fishery in 1879–80.

Branches of the industry.	No of boats and vessels.	Value of boats and vessels.	No of persons employed.
Dredging	700	$1,050,000	5,600
Scraping	550	440,000	2,200
Tonging	1,825	182,500	5,148
Transporting	200	300,000	800
Total	3,275	1,972,500	13,748

Oysters caught, number of bushels = 10,600,000.

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*Étude sur l'Industrie Huitrière des États-Unis. Paris, 1865.

Present extent of the industry.—The following tables compiled for this report exhibit by counties the extent of the various branches of the oyster industry for the seasons 1890–91 and 1891–92:

TONGING, 1890-91.

Counties.	No. of men.	Vessels tonging.				Boats tonging.		Total vessels and boats.		Value of tongs.	Total catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	1,405					923	$67,105	923	$67,105	$9,216	1,094,935	$522,774
Wicomico	850					344	31,925	344	31,925	5,670	353,500	176,621
Dorchester	1,443					1,003	60,180	1,003	60,180	7,498	409,660	205,292
Talbot	1,237					656	44,090	656	44,090	7,918	402,000	201,000
Queen Anne	1,112					488	30,086	488	30,086	5,065	367,375	204,374
Kent	769					410	19,609	410	19,609	4,305	236,500	141,388
Anne Arundel	1,957	55	440.85	$25,790	$5,250	595	45,500	650	71,290	12,442	591,505	321,530
Calvert	1,077	9	75.92	5,315	750	512	25,016	521	30,361	10,770	264,730	146,677
St. Mary	1,380	1	12.85	750	90	756	43,125	757	43,875	10,410	463,967	267,241
Charles	192					155	5,673	155	5,673	1,020	54,518	27,849
Worcester	192	3	20.62	1,150	85	112	6,480	115	7,630	795	115,143	93,070
Total	11,614	68	550.24	33,035	6,175	5,954	378,789	6,022	411.824	75,109	4,353,833	2,307,816

TONGING, 1891-92.

Counties.	No. of men.	Vessels tonging				Boats tonging.		Total vessels and boats.		Value of tongs.	Total catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	1,355					890	$65,220	890	$65,220	$8,860	1,065,530	$486,230
Wicomico	830					333	31,025	333	31,025	4,830	370,825	175,820
Dorchester	1,352					933	59,480	933	59,480	7,015	450,720	212,805
Talbot	727					512	36,070	512	36,070	4,835	324,650	159,180
Queen Anne	1,064					564	37,590	564	37,590	5,180	420,160	209,615
Kent	862					510	29,480	510	29,480	4,965	345,820	174,130
Anne Arundel	1,834	41	326.70	$19,865	$4,300	574	44,210	615	64,075	11,625	667,295	328,975
Calvert	1,102	8	70.18	5,200	710	523	28,350	531	33,550	11,010	334,640	173,915
St. Mary	1,394					759	43,990	759	43,990	11,015	487,675	274,210
Charles	167					122	5,105	122	5,105	940	44,500	21,840
Worcester	126					89	5,370	89	5,370	525	94,520	80,640
Total	10,813	49	396.88	25,065	5,010	5,809	385,890	5,858	410,955	70,800	4,606,385	2,296,860

The extent of the bedding or planting industry is here included. This is so small, amounting to about one-seventieth of the extent of the tonging fishery, that this arrangement does not preclude the use of the foregoing figures as an exposition of the extent of the common fishery as prosecuted by means of tongs.

DREDGING, 1890-91.

Counties.	No. of men.	Vessels dredging.				Boats dredging.		Total vessels and boats.		Value of apparatus.	Total catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	2,458	412	7,338.63	$329,420	$124,060	13	$2,610	425	$332,030	$37,745	1,823,030	$913,080
Wicomico	88	13	305.41	14,225	4,815			13	14,225	1,742	42,190	22,085
Dorchester	203	31	649.10	30,215	10,640			31	30,215	3,620	84,500	43,300
Talbot	78	18	170.37	8,420	4,220			18	8,420	1,820	46,160	24,235
Kent	11	2	31.45	1,075	352			2	1,075	125	2,800	2,150
Baltimore	2,015	235	7,591.44	228,645	84,694			235	228,645	21,150	767,046	554,231
Anne Arundel	40	11	121.16	9,615	1,505			11	9,615	550	23,900	16,300
Calvert	119	19	410.70	22,805	3,035	4	680	23	23,485	1,445	56,550	36,300
St. Mary	208	18	215.90	12,475	2,400	45	3,820	63	16,295	2,350	63,106	34,224
Total	5,215	759	16,834.16	656,895	235.721	62	7,110	821	664,005	70,547	2,909.282	1,645,905

Of the foregoing, 183 vessels (2,648.23 tons) and 13 boats from Somerset, 16 vessels (156.31 tons) from Dorchester, and 9 vessels (81.24 tons) from Talbot, engaged in scraping within the limits of those counties, catching 465,000, 20,000 and 8,000 bushels respectively, reducing the catch in "State waters" to 2,416,282 bushels, with a value of $1,405,905.

DREDGING, 1891-92.

Counties.	No. of men.	Vessels dredging.				Boats dredging.		Total vessels and boats.		Value of apparatus.	Total catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	2,225	351	6,739.87	$306,145	$116,750	11	$2,890	362	$309,035	$32,575	1,993,220	$864,195
Wicomico	28	5	94.05	4,975	2,200	....	....	5	4,975	585	19,350	9,680
Dorchester	283	42	799.44	37,620	14,680	....	....	42	37,620	4,060	165,085	70,120
Talbot	54	12	121.53	6,100	2,650	....	....	12	6,100	965	44,130	18,885
Kent	14	2	52.04	2,100	380	...	....	2	2,100	210	8,235	4,300
Baltimore	1,964	221	6,992.34	221,670	84,875	....	....	221	221,670	20,480	1,123,715	621,460
Anne Arundel	114	25	333.42	24,210	5,400	1	450	26	24,660	1,710	86,280	38,350
Calvert	167	20	228.22	15,850	3,100	20	3,425	40	19,275	2,255	109,850	56,100
St. Mary	204	19	257.56	13,440	3,500	39	2,630	58	16,070	2,430	102,500	54,120
Charles	6	2	42.42	2,600	300	....	....	2	2,600	160	5,600	3,100
Total	5,059	699	15,660.39	634,710	233,835	71	9,395	770	644,105	65,430	3,657,965	1,740,310

Of the foregoing, 178 vessels (2,385.60 tons) and 11 boats from Somerset, 16 vessels (153.70 tons) from Dorchester, and 4 vessels (36.20 tons) from Talbot County engaged in scraping within the limits of those counties, catching 500,000, 20,000, and 4,000 bushels, respectively, reducing the catch by dredging in "State waters" to 3,133,965 bushels, with a value at first hands of $1,502,310.

SCRAPING, 1890-91.

Counties.	No. of men.	Vessels.				Boats.		Total vessels and boats.		Value of apparatus.	Catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	1,416	105	931.80	$47,185	$26,225	331	$78,210	436	$125,395	$20,509	1,319,317	$663,498
Dorchester	1,806	268	459.59	129,935	53,447	266	34,580	534	155,515	23,051	1,157,786	577,390
Talbot	383	23	2,196.79	10,455	4,090	79	18,160	102	28,615	3,410	204,840	101,257
Total	3,605	396	3,587.68	187,575	83,762	676	130,950	1,072	309,525	46,970	2,681,943	1,342,145

In addition to the foregoing, 183 dredging vessels (2,648.23 tons) and 13 boats from Somerset, 16 dredging vessels (156.31 tons) from Dorchester, and 9 dredging vessels (81.24 tons) from Talbot engaged in scraping within the limits of those counties, catching therein 465,000, 20,000, and 8,000 bushels, respectively, thus increasing the catch on scraping areas to 3,174,943 bushels, with a value to the oystermen of $1,582,145.

SCRAPING, 1891-92.

Counties.	No. of men.	Vessels.				Boats.		Total vessels and boats.		Value of apparatus.	Catch.	
		No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.		Bushels.	Value.
Somerset	1,514	116	1,036.42	$53,015	$27,960	338	$79,685	454	$132,700	$21,620	1,472,630	$651,280
Dorchester	1,952	286	2,602.38	131,420	56,975	280	37,590	566	169,010	25,050	1,715,450	701,060
Talbot	291	18	145.82	8,875	3,640	56	14,520	74	23,395	2,735	180,300	76,610
Total	3,757	420	3,784.62	193,310	88,575	674	131,795	1,094	325,105	49,405	3,368,380	1,428,950

In addition to the foregoing, 178 vessels (2,385.60 tons) and 11 dredging boats from Somerset, 16 dredging vessels (153.70 tons) from Dorchester, and 4 dredging vessels (36.20 tons) from Talbot engaged in scraping within the limits of those counties, catching 500,000, 20,000, and 4,000 bushels, respectively, thus increasing the catch on scraping areas to 3,892,380 bushels, with a value of $1,666,950.

It should be observed that those vessels and boats engaged both in dredging and scraping are reported only under the former caption, in order to avoid a duplication of the property and men employed in the fishery. Many estimates heretofore made on the extent of this industry failing to note this duplication have thereby reported 225 vessels and boats, 1,000 men, and a catch sometimes amounting to over 1,000,000 bushels more than was actually the case.

TRANSPORTING.

Counties.	1890-91.					1891-92.				
	Vessels.				No. of men.	Vessels.				No. of men.
	No.	Tonnage.	Value.	Value of outfit.		No.	Tonnage.	Value.	Value of outfit.	
Somerset	60	2,005.24	$91,150	$13,822	266	78	2,399.48	$120,360	$17,100	331
Wicomico	10	383.65	19,500	2,495	46	15	564.17	30,260	3,600	63
Dorchester	45	1,981.84	98,100	10,735	198	41	1,956.16	92,850	9,650	179
Talbot	3	100.94	5,200	590	11	5	138.50	7,350	980	20
Queen Anne	18	344.95	15,150	2,336	48	19	367.84	17,200	2,800	59
Kent	40	637.02	20,350	3,873	87	39	620.05	20,100	3,950	85
Baltimore	152	5,741.73	219,675	16,899	552	194	7,266.83	269,375	25,820	693
Anne Arundel	28	492.32	27,050	2,233	78	22	352.84	22,625	1,840	62
Calvert	22	894.07	49,175	3,465	84	21	865.13	47,875	3,400	81
St. Mary	21	529.69	23,650	2,742	74	22	536.29	25,240	3,150	78
Total	390	13,111.45	569,000	59,190	1,444	456	15,067.29	653,235	72,290	1,651

Condensed tables exhibiting the extent of the various branches of the fishery.

1890-91.

Items.	Persons engaged.	Vessels and boats.		Value of apparatus.	Value of outfit.	Total capital invested.	Products.	
		No.	Value.				Bushels.	Value.
Tonging	11,614	6,022	$411,824	$75,109	$6,175	$493,108	4,353,833	$2,307,816
Dredging	5,215	821	664,005	70,547	235,721	970,273	2,909,282	1,645,905
Scraping	3,605	1,072	309,525	46,970	83,762	440,257	2,681,943	1,342,145
Transporting	1,444	399	569,000	....	59,190	628,190	....	*370,000
Total	21,878	8,314	1,954,354	192,626	384,848	2,531,828	9,945,058	5,665,866

1891-92.

Tonging	10,813	5,858	410,955	70,800	5,010	486,765	4,606,385	2,296,860
Dredging	5,059	770	644,105	65,430	233,835	943,370	3,657,965	1,740,310
Scraping	3,757	1,094	325,105	49,405	88,575	463,085	3,368,380	1,428,950
Transporting	1,651	456	653,235	....	72,290	725,525	....	*400,000
Total	21,280	8,178	2,033,400	185,635	399,710	2,618,745	11,632,730	5,866,120

* Enhancement in value of oysters transported.

NOTE.—Sufficient data are not at hand to exhibit similar tables for 1892-93, but the information from the various oystering centers indicates that the yield during that season was about 10,142,500 bushels, for which the oystermen and transporters received $5,500,000. Of this amount 4,432,500 bushels were obtained by tongmen, 3,100,000 by dredgers, and 2,610,000 by scrapemen, the total number of men employed approximating 21,200.

GRAND SUMMARY.

1890-91.	Persons engaged.	Amount of capital employed.	1891-92.	Persons engaged.	Amount of capital employed.
Oystering and transporting	21,878	$2,531,828	Oystering and transporting	21,280	$2,618,745
Marketing	11,293	4,316,475	Marketing	12,108	4,650,500
Total	33,171	6,848,303	Total	33,388	7,269,245

The total extent to which Maryland is dependent on the oyster fishery is not fully indicated in the foregoing tables. The amount of money received by the oystermen for their product poorly represents the value of this industry. In the eleven counties in which the fishery is prosecuted it is the mainstay of the people, and the prosperity of nearly all business therein is regulated by it. As four-fifths of the oysters are sent out of the State through wholesale markets, etc., and as the value of the product after it has passed through these markets and transportation agencies averages about 90 cents for each bushel originally represented, it is reasonable to assume that for each bushel of oysters caught in Maryland about 70 cents is brought into the State. During the last ten years this would amount to about $80,000,000 received by the oystermen, marketmen, transportation agencies, etc., which would not have been brought into the State were it not for the oyster fishery, and this does not include the value of the millions of bushels of oysters consumed within the State. This sum is much greater than the total taxable value of all property located in the counties in which this fishery is prosecuted, not including the city of Baltimore.

At least 95 per cent of this revenue is received by men whose wages or incomes amount to less than $1,000 a year. In this class are included all the oystermen and nearly all the employés of the shucking-houses and transportation agencies. Then, when consideration is taken of the large number of persons engaged in other vocations, but dependent on the patronage of these men to a greater or less extent, such as vessel builders and repairers, sail-makers, blacksmiths, house carpenters, grocerymen, merchants, even the physicians, lawyers, etc., the enormous value of the industry is apparent, and it is observed how vitally important to the people of the State is the continued prosperity of the fishery.

A careful survey of the extent of the oyster product of Maryland from the beginning of the present century develops the following as an approximation of the product during each decade, not including those taken by non-residents or those used for fertilizing purposes:

Period.	No. of bushels.	Period.	No. of bushels.
1800–1810	2,500,000	1860–1870	63,000,000
1810–1820	4,000,000	1870–1880	114,000,000
1820–1830	5,000,000	1880–1890	116,000,000
1830–1840	8,000,000	1890–1893	31,720,000
1840–1850	15,000,000		
1850–1860	34,000,000	Total	393,220,000

To exhibit the comparative value of this product, the following tabular statement is submitted showing the average prices received at Baltimore during the seasons indicated for "straight up" or standard stock. These figures are a trifle higher than the average for the product of the State:

Season.	Average price per bushel.	Season.	Average price per bushel.
	Cents.		*Cents.*
1850–51	30	1880–81	40
1855–56	30	1885–86	45
1860–61	35	1889–90	53
1865–66	*70	1890–91	69
1870–71	35	1891–92	62
1875–76	33	1892–93	66

*War prices.

STATE REVENUE AND FISHERY FORCE.

The State as a landlord.—Let us now view the oyster industry from another standpoint, and, remembering that the extensive areas of reefs are the properties not of the oystermen but of the State at large, examine Maryland's record as a financier in controlling these properties, omitting consideration for the time being of her position as legislator and patron of the industries within her limits.

Comparatively few of the United States have considered it expedient to burden any branch of the fisheries with a special tax; on the contrary the fishermen have at times been the recipients of assistance in the form of relief from certain general taxes or in the granting of bounties. But there is a growing tendency to consider the taking of oysters different from the ordinary fisheries and to cause it to bear some special part in paying the expenses of the State aside from the ordinary taxation of the property engaged in the business.

Maryland was among the first of the States to impose a tax upon the catching of oysters, this being in 1854, when the local scraping license for Somerset County was authorized, followed in 1865 by the adoption of the general license system. Since 1854 and up to the close of the fiscal year 1893 the revenue received from the issuing of oystering licenses by this State has amounted to $1,781,520.61, not including the revenue from fines imposed for violating the oyster laws, as this can not be considered a tax on the fishery. This is a greater amount than all the remaining States of America have received by special taxation from all branches of their free and private fisheries combined. All of this money has not been paid directly into the treasury of the State, a portion of it being devoted to the purposes of the counties in the waters of which the licenses authorized oystering; nevertheless it is public revenue, collected by authority of the general assembly and subject to disposition thereby.

The following table exhibits by fiscal years (October 1–September 30) the license fees received from each branch of the fishery, the rate of fees required during each season having been exhibited on the preceding pages:

Table exhibiting the license revenue during each fiscal year from the various branches of the oyster fishery.

Years.	Tonging.	Dredging.	Scraping.	Total.
1854-64....	....	....	$51,380.00	$252,582.52
1864-65....	$1,919.10	$12,111.20		
1865-66....	8,098.75	48,463.22		
1866-67....	6,183.44	22,515.29		
1867-68....	11,669.20	32,535.90		
1868-69....	10,905.50	46,800.86		
1869-70....	9,409.80	38,675.80	2,830.00	50,915.60
1870-71....	7,900.00	41,587.46	5,172.00	54,659.46
1871-72....	8,790.45	39,039.62	5,776.00	53,606.07
1872-73....	8,969.00	54,159.46	4,954.00	68,082.46
1873-74....	7,420.50	30,227.77	4,206.00	41,854.27
1874-75....	7,454.00	42,355.58	4,923.42	54,733.00
1875-76....	6,797.00	48,468.68	4,418.04	59,683.72
1876-77....	6,382.00	49,837.46	3,625.65	59,845.11
1877-78....	5,504.00	37,408.39	2,623.20	45,535.59
1878-79....	6,075.00	31,173.29	3,472.50	40,720.79
1879-80....	$7,025.00	$18,606.50	$2,689.40	$28,320.90
1880-81....	8,182.85	40,589.98	3,986.14	52,708.47
1881-82....	8,422.00	52,582.05	4,108.85	65,112.90
1882-83....	8,752.00	48,841.64	5,241.00	62,834.64
1883-84....	9,161.00	45,127.65	5,730.62	60,019.27
1884-85....	15,627.00	69,528.72	6,489.94	91,645.66
1885-86....	13,083.00	49,631.59	9,752.08	72,466.67
1886-87....	12,626.00	52,411.68	9,620.64	74,658.42
1887-88....	13,082.00	48,675.54	8,321.34	70,078.88
1888-89....	13,812.00	57,928.72	8,374.29	80,115.01
1889-90....	15,741.00	52,945.27	10.440.43	79,127.70
1890-91....	24,943.00	50,275.03	15,176.95	90,394.98
1891-92....	22,888.00	44.744.73	13,667.93	81,290.66
1892-93....	32,353.50	44,781.72	13,333.74	90,468.96
Total...	319,175.65	1,252,030.80	210,314.16	1,781,520.61

From the foregoing table it is observed that during the last five years the revenue from tonging, dredging, and scraping has been $109,737.50, $250,675.47, and $60,993.34, respectively, or an annual average of $21,947.50, $50,135.09, and $12,198.67. The area of the natural reefs on which these three forms of fishery are prosecuted has been found to be about 154, 121, and 80 square miles, respectively, and the average annual product during the last five years, 4,850,000, 3,450,000, and 2,750,000 bushels. These data form the basis of the following tabular statement:

Form of fishery.	Area, square miles.	Product, bushels.	Annual revenue, average for five years.	Average revenue.	
				Per square mile.	Per 1,000 bushels.
Tonging	154	4,850,000	$21,947.50	$142.51	$4.52
Dredging	*121	3,450,000	50,135.09	414.33	14.53
Scraping	80	2,750,000	12,198.67	152.48	4.43
Total	355	11,050,000	84,281.26		
Average				237.41	7.62

* Of this area 42 square miles are used also by Virginia oystermen.

The foregoing table exhibits the annual average rate of revenue for the last five years, but as the license fees for tonging were increased in 1892 it does not properly exhibit the extent of the tax which that branch of the fishery is now paying, and the following table is submitted for this purpose, showing the condition of the license-revenue receipts for the season 1892–93:

License-revenue receipts for 1892–93.

Form of fishery.	Area, square miles.	Product, bushels.	Annual revenue.	Average revenue.	
				Per square mile.	Per 1,000 bushels.
Tonging	154	4,432,500	$32,353.50	$210.09	$7.30
Dredging	121	3,100,000	44,781.72	370.14	14.44
Scraping	80	2,610,000	13,333.74	166.67	5.10
Total	355	10,142,500	90,468.96		
Average				254.84	/ 8.92

The fact that about 200 vessels and boats work under both a dredging and a scraping license complicates somewhat the consideration of the proportionate revenue per square mile or per 1,000 bushels for those two forms of fishing. In the two foregoing tables the catch made by these craft has been noted entirely under dredging. Were it practicable to exhibit with greater accuracy these average items for the two branches of fishery indicated the average revenue from dredging per square mile would be slightly decreased and the revenue per 1,000 bushels would be slightly increased and an opposite effect would be produced in these two items for the scraping branch of the fishery, but the change effected would not be material.

It is thus observed that during the last season the dredgers have paid twice as much revenue or tax per 1,000 bushels as the tongmen and nearly three times as much as the scrapemen. The total revenue during that season averaged $8.92 per 1,000 bushels, or $254.84 per square mile, or 40 cents per acre. As the oystermen received about $5,500,000 for their catch, the State revenue was at the rate of over $16 per $1,000 worth of oysters.

The total revenue since the adoption of the license system being $1,781,520.61, and the area of the reefs approximating 355 square miles, the State has up to the present time received from the reefs, in the form of license fees, an average of $5,018.36 per square mile or $7.84 per acre.

As we can judge of the ability of one financier only by comparing his operations with those of others, let us examine what has been done by other States so far as deriving a revenue from the public oyster reefs is concerned. The following oyster-producing States derive no revenue from this source: Massachusetts, Rhode Island, New York, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Texas, California, Oregon, Washington.

Prior to 1893 Connecticut did not tax her oystermen for working on the public reefs, but in that year adopted a license system on the following basis: For each boat or vessel working on the public reefs the owner thereof is required to pay annually the sum of $2 if the boat or vessel measures less than 5 tons, but if it measures over 5 tons he is required to pay 50 cents for each additional ton.

In New Jersey the only public-reef oystermen subjected to special taxation are those who gather oysters from the waters of Cumberland County in Delaware Bay. These men are required to obtain a license at the rate of $5 on all craft not over 5 tons, and $1 per ton, custom-house measurement, on all boats and vessels exceeding that tonnage. The total revenue amounts to about $5,000 annually, while the catch is about 1,300,000 bushels valued at $400,000, the area of the natural beds being about 60,000 acres. But this revenue is not so much a tax on the public-reef oystermen as upon the planting operations of that region, for the license also permits without further cost the preëmption of sufficient area of ground in Delaware Bay for planting the oysters obtained from the public reefs, this area being about 10,000 acres.

Within the limits of Pennsylvania there are no oyster beds whatever, either public or private. The oysters usually credited to that State are gathered from the beds situated within New Jersey and Delaware and are obtained in accordance with the regulations of those States.

In Delaware each tongman, with a few minor exceptions, is required to obtain an annual license, costing $5. The number of men licensed during each of the last six seasons has been as follows: 1887, 61; 1888, 67; 1889, 68; 1890, 80; 1891, 48; 1892 (September 1, 1892, to March 31, 1893), 68. The catch amounts to about 120,000 bushels annually, valued at $32,000. The dredging regulations in Delaware are quite similar to those operative in Cumberland County, N. J., the license authorizing the preëmption of ground for planting purposes in addition to permitting the gathering of oysters from the public reefs. The fee is $3 per ton, and the revenue amounts to about $600 annually. The area of reefs on which the dredgers operate is about 4,500 acres, and the annual catch is about 85,000 bushels, valued at $20,000.

In Virginia dredging vessels are required to pay a license fee of 50 cents per ton for each month in which they are engaged, and each tongman is required to pay annually the sum of $2 and an additional fee of 50 cents for each boat used. The constitution of the State interdicts the taxing of tongs used on oyster reefs; but conflict with this is avoided by providing, under an elaborate system, for a tax on the quantity of oysters caught and permitting the tongmen to pay an annual fee of $2 in lieu thereof. From 1880 to 1891, inclusive, the Virginia receipts from all forms of oyster-license tax in the State amounted to $120,153.83 and the disbursements for the oyster police force, etc., were $163,197.43.

The present license system became operative in 1884, and the annual receipts and disbursements since then have been as shown in the following tabular statement:

Virginia oyster fund.

Fiscal year.	Receipts.	Disbursements.
1884	$919.93	$18,907.97
1885	26,476.93	27,025.66
1886	22,949.89	22,574.25
1887	13,329.21	16,712.35
1888	13,755.89	18,922.82
1889	12,455.56	17,190.94
1890	12,817.53	19,561.73
1891	14,114.83	21,683.92
Total	116,819.77	162,579.64

These figures include a small revenue from taxing the private planting-grounds; this, however, is so small that for the purposes of the present discussion they may be considered as representing only the revenue from the public reefs.

In Louisiana, the remaining State which provides for taxing public-reef oystermen, tonging is the only form of oystering permitted, and the license system regulating it is based on that of Virginia, even to the adoption of the complicated system which the latter State provided in order to avoid conflict with its constitution. The fee in Louisiana is at the rate of 50 cents annually for each boat employed, and an additional 50 cents every three months for each man engaged. Difficulty, however, has been experienced in collecting the revenue and the regulation is practically inoperative.

An approximation, for the last year for which data are at hand, of the product of the natural or public oyster reefs of each of the United States and the license receipts therefrom is contained in the following table:

Product of public oyster reefs and State revenue therefrom.

State.	Public oyster reefs.		Revenue.	Year.
	Bushels.	*Value.*		
Massachusetts	25,000	$15,000		1892
Rhode Island	16,865	7,858		1892
Connecticut	211,090	68,589		1892
New York	810,629	485,730		1891
New Jersey	1,300,000	400,000	$5,200	1892
Delaware	205,272	51,872	940	1892
Virginia	5,690,700	2,290,850	14,115	1891
North Carolina	807,260	175,567		1890
South Carolina	63,150	23,204		1890
Georgia	224,357	40,520		1890
Florida	468,431	108,542		1890
Alabama	481,070	107,812		1890
Mississippi	806,478	166,672		1890
Louisiana	820,000	260,000		1890
Texas	440,800	127,990		1890
Washington	142.730	127,000		1892
Oregon	2,500	3,125		1892
Total	12,516,332	4,460,331	20,255	
Maryland	10,142,500	5,500,000	90,469	1893

Of the Maryland revenue, all of the dredging fees have been paid into the State treasury and the greater portion of the tonging and scraping fees into the treasuries of the counties wherein the licenses were respectively issued. Prior to 1874–75 all of the tonging fees, amounting to $81,266.25, were paid into the State treasury, and the receipts from this branch of the fishery in 1892–93, under the new license system, amounted to $2,672.70, making a total of $83,938.95 that has been paid into the treasury of the State out of the $319,175.65 revenue from tonging licenses.

Of the revenue from scraping licenses, nothing was paid into the State treasury prior to 1892–93 except the revenue in Dorchester County in 1870–71 and 1871–72, which amounted to $3,008. In 1892 it was required that 10 per cent of the revenue from scraping licenses, after deducting 5 per cent for collection, should be paid into the State treasury. The revenue from the latter source in 1892–93 was $1,266.63, making a total of $4,274.63 received into the State treasury out of a total of $210,314.16 received in fees from this branch of the fishery. These figures form the basis of the following table:

Total revenue received from oyster licenses in Maryland.

Depository.	Tonging.	Dredging.	Scraping.	Total.
State treasury	$83,938.95	$1,252,030.80	$4,274.63	$1,340 244.38
County treasuries	235,236.70		206,039.53	441,276.23
Total	319,175.65	1,252,030.80	210,314.16	1,781,520.61

In addition to the foregoing items the State treasury has received since 1884 one-tenth of a cent for every bushel of oysters used at the steaming-houses, this amounting to $22,461.20 to the present date; also since 1865 from oyster measurers, fines, and other sources, $89,807.25; and the counties have collected about $55,000 from the imposing of oyster fines, etc. This makes a grand total of $1,948,789.04 collected from all branches of the oyster industry since the establishment of the license system. Of this revenue, $1,452,512.83 has been paid into the State treasury to the credit of the "oyster fund," and "packers' fund," and $496,276.23 has been received into the treasuries of the tide-water counties.

The revenue paid into the county treasuries has been devoted mostly to public-school purposes, a very small portion being used for enforcing the oyster regulations in certain counties, and in Worcester and Somerset counties in the planting of oyster shells for the extension and improvement of the oyster reefs. In 1892–93 the clerks of the circuit courts received $5,264.18 for issuing the tonging and scraping licenses, but prior to that season they received nothing.

The "oyster fund" of the State treasury has been used chiefly in equipping and maintaining the fishery force, about $1,200,000 having been devoted to that purpose up to the close of the fiscal year 1893. Numerous other items have assisted in diminishing this fund, among which may be mentioned the refunding of transportation license fees collected in 1884 and 1885, amounting to $27,644.15; the expenditure of $4,892.35 in an experiment in planting oyster shells; the expenses of various State commissions or legislative committees appointed to investigate certain features of the industry; painting numbers for the dredging vessels; court procedures, etc.

The following table exhibits by fiscal years the receipts and disbursements of the State "oyster fund" since the origin of the general license system:

Receipts and disbursements of the State oyster fund, since the origin of the general license system.

Fiscal year ending Sept. 30.	Receipts from dredging.	Total receipts.	Disbursements.	Balances.
1865....	$12,111.20	$14,030.20	....	$14,030.20
1866....	48,463.22	56,561.97	....	70,592.17
1867....	22,515.29	28,778.65	$80.85	99,289.97
1868....	32,535.90	45,326.87	21,321.91	123,294.93
1869....	46,800.86	61,301.49	28,186.80	156,409.62
1870....	38,675.80	50,096.74	32,381.79	174,126.57
1871....	41,587.46	53,136.96	23,675.29	203,588.24
1872....	39,039.62	50,782.27	23,076.17	231,294.34
1873....	54,159.46	65,490.55	24,770.75	272,014.14
1874....	30,227.77	36,278.65	36,882.97	271,409.82
1875....	42,355.58	43,560.53	67,484.87	247,485.48
1876....	48,468.68	50,764.78	48,368.00	249,882.26
1877 ...	49.837.46	51,078.76	50,136.76	250,824.26
1878....	37,408.39	38,426.83	41,683.86	247,567.23
1879....	31,173.29	31.969.12	44,379.76	235,156.59
1880....	18,606.50	19,411.04	41,784.97	212,782.66
1881....	$40,589.98	$44,925.71	$38,403.62	$219,304.75
1882....	52,582.05	57,751.05	39,070.59	237,985.21
1883....	48,841.64	56,075.32	54,114.13	239,946.40
1884....	45,127.65	67,650.78	62,704.83	244,892.35
1885....	69,528.72	79,704.17	127,089.56	197,506.96
1886....	49,631.59	51,057.74	106,600.62	141,964.08
1887....	52,411.68	55,561.73	67,221.88	130,303.93
1888....	48,675.54	53,236.69	67,913.13	115,627.49
1889....	57,928.72	61,562.08	63,306.09	113,883.48
1890....	52,945.27	58.178.67	70,955.91	101,106.24
1891....	50,275.03	52,260.33	73,645.81	79,720.76
1892....	44,744.73	46,652.83	79,665.11	46,708.48
1893....	44,781.72	48,437.12	91,302.03	3,847.57
Total.	1,252,030.80	1,430,051.63	1,426,204.06	....

The State fishery force.—Prior to 1865 the enforcement of the oyster regulations was left to the care of the sheriffs and constables with the assistance of the posse comitatus and such vessels or steamers as they might desire to impress into their temporary service, the same being at the risk and expense of the State. When the license system was adopted in 1865 all captains and employés of licensed vessels and boats were constituted officers of the State, with full powers of sheriffs in the enforcement of the oyster laws. In 1867 (ch. 184) the comptroller of the treasury was authorized, at such times as he might think the interests of the State required, to charter a steamer properly manned and equipped to cruise in the bay for special periods of time not exceeding ten days, to overhaul and examine the vessels engaged in oystering, and to arrest offenders. All of these methods proved so ineffectual that in 1868 (ch. 406) provision was made for an "oyster police force," now officially designated the "State fishery force," but popularly known as the oyster navy; and an appropriation was made for the purchase of one steamer and two sail vessels to be kept constantly cruising in the waters of the State where violations of the oyster regulations might be expected. The control of this force was vested in the "board of public works," consisting of the governor and certain other officials of the State. This board was authorized to properly equip and provision the vessels and supply them with competent officers and men.

The fleet obtained consisted of one steamer of 113 tons burden and two fast-sailing vessels well equipped with boats and with 5 men each. Both steamer and sail vessels were supplied with cannon and ammunition, which they were authorized to use in enforcing the oyster regulations. One of the sailing vessels patrolled the Chesapeake and tributaries above the Patuxent and the other one below that point, while the steamer was kept cruising over the entire bay and tributaries. In 1874 six additional vessels were added to the force, at a cost of $20,000; in 1882, 1883, and 1884 additional vessels were added, and in 1885 two steamers were obtained at a cost of $62,000. In 1888 the old steamer was disposed of and additional sail vessels added.

At present the force consists of 2 steamers, 9 schooners, 2 sloops, and 8 smaller and "local" boats. The latter are employed for six months only and are provided by certain counties to enforce the oyster regulations within their respective limits, yet are under the direction of the commander of the State force. They carry 3 or 4 men each and are armed with rifles. Of the State vessels, the steamers each have a crew numbering 12 men, and the schooners and sloops have 6 men each, all vessels being furnished with one cannon and a number of rifles. This makes a total of 120 men in the force, and the cost of maintaining the fleet, including all salaries, provisions, ammunition, repairs, etc., has during the last five years averaged about $65,000 annually.

One of the sail vessels patrols the Chester River including Swan Point; one the Eastern Bay and tributaries and the waters of Talbot County as far down as Black Walnut Point; one the Choptank River and tributaries, one the Little Choptank River; one the waters of Fishing Bay, Honga River, Tar Bay, Hooper Straits, and Holland Straits; one the waters of Wicomico County, one the waters of Somerset County; two the waters of Anne Arundel, and two the waters of Calvert, St. Mary and Charles counties, while the steamers cruise throughout the State except in the Sinepuxent Bay.

The principal duties of the force are to see that no one engages in oystering without obtaining a license, to prevent the dredgers from oystering on the reefs used by the scrapemen, and to prevent both dredgers and scrapemen from resorting to the areas reserved for the tongmen, to enforce the close season, the cull law, and the various minor regulations of the oyster industry, as well as the fish and water-fowl laws of the State. While during certain years this fleet has not succeeded in accomplishing as much as some persons expected of it, yet considering the extensive area of water to be guarded and the thousands of oyster boats and vessels at work, it is not surprising that violations of the regulations occur.

The most noticeable violations of the regulations are made by the dredgers in frequenting areas reserved for the tongmen. These became especially prominent in the fall of 1888. The police vessels were not so well armed then as at present and the oystermen lost confidence in the ability of the force, in the fights occurring, the former being frequently routed by the dredgers. On several occasions during that year a number of dredging vessels combined and openly defied the fishery force. This aroused popular attention; the fleet was better provided with arms and ammunition, its personnel reorganized, several dredging vessels were sunk, and a few men killed. Since then the oystermen have had greater respect for the law, and while at times a dredger may trespass on forbidden areas it is usually done under cover of darkness or fog, and such violations are not by any means so frequent as formerly.

Prior to 1880 the members of the crew as well as the captain of the vessel were held liable for violations of the oyster laws, and the vessel was allowed to go free. When caught, the captain and crew were placed in jail, but the former was usually bailed out and his fine paid if the case ultimately went against him. The crew being penniless and without friends frequently remained in jail for months, imposing an expense on the county. Many of these men were foreigners and very few of them were familiar with the laws regulating the fishery, and it was manifestly unjust to make them suffer for obeying the orders of their captains. This has since been remedied, and the penalty for violating the oyster laws is now properly shared by the vessel.

CONCLUSION.

The common fishery.—From the data presented on the preceding pages is obtained the following tabular statement, exhibiting for a period of years the total number of persons employed in the oyster fishery of Maryland and the total quantity and value of the products:

Season.	No. of men.	Bushels of oysters.	Value.	Season.	No. of men.	Bushels of oysters.	Value.
1860-61	3,000	3,000,000	$1,050,000	1889-90	20,481	10,450,087	$5,204,456
1868-69	6,885	8,040,970	2,814,340	1890-91	21,878	9,945,058	5,665,866
1869-70	7,470	9,233,475	3,231,716	1891-92	21,280	11,632,730	5,866,120
1870-71	7,582	8,947,803	3,031,731	1892-93	21,200	10,142,500	5,500,000
1879-80	13,748	10,600,000	3,869,000				

It is surprising and contrary to what might be expected from observations in other States and countries that the oyster reefs of Maryland have continued so long to produce oysters in such abundance, notwithstanding the vigorous fishery to which they have been subjected. But it will be observed that while little variation has existed during the last twenty-five years in the quantity of oysters obtained annually, there has been a very large increase in the number of persons, vessels, and boats employed, indicating a decrease in the average catch per man and necessitating an increase in the price of the oysters.

The following table exhibits for a number of seasons the average catch of oysters and the average gross income for each man engaged in the fishery:

Season.	Average per man.		Season.	Average per man.	
	Bushels of oysters.	Gross income.		Bushels of oysters.	Gross income.
1860-61*	1,000	$350	1889-90	510	$254
1868-69	1,168	409	1890-91	455	259
1869-70	1.236	432	1891-92	547	275
1870-71	1,180	399	1892-95	478	259
1879-80	771	281			

* No dredging.

It is thus observed that according to the data at hand the present average catch per man is less than one-half of what it was twenty-three years ago, and only two-thirds of what it was thirteen years ago, notwithstanding the fact that the boats and apparatus of capture used at present are far more costly and effective, and because of the higher prices the fishery is more vigorously prosecuted than was formerly the case; also the gross incomes of the oystermen are constantly decreasing, being now less than two-thirds of what they were in 1870, notwithstanding the greater expenses which they incur.

In the meantime another and more serious change has taken place. The fishery being more extensively followed year after year, sufficient time is not given the oysters to attain their full growth, resulting naturally in a decrease in the average size of those brought to market. This decrease has been very noticeable, and the following tabular statement is presented, exhibiting for a period of years the proportion of "extra selects" among the Chesapeake oysters handled by Messrs. Platt & Co., one of the largest raw-shucking firms in Baltimore, this probably being an average for all the dealers in that city:

Season.	Proportion of extra selects to total quantity.	Season.	Proportion of extra selects to total quantity.
1883-84	$\frac{1}{10}$	1888-89	$\frac{1}{43}$
1884-85	$\frac{1}{12}$	1889-90	$\frac{1}{53}$
1885-86	$\frac{1}{25}$	1890-91	$\frac{1}{75}$
1886-87	$\frac{1}{27}$	1891-92	$\frac{1}{85}$
1887-88	$\frac{1}{33}$		

No statistics are available with which to exhibit the comparative sizes of the oysters caught prior to 1883; but if the very general complaints prevalent throughout the Chesapeake during the last decade in reference to the decreased size of the oysters are well grounded, it is evident that the decrease since 1870 has been very great. This decrease in the size of the oysters is of more consequence than its effect on the markets or on Maryland's prestige as a producer of superior-grade oysters. It is a principle in the economy of nature that a species should be reproduced by the best developed and hardiest of its kind. On this principle the progeny of a colony of oysters not yet attained mature development can scarcely be expected to be so vigorous and capable of combating the many adverse agencies to which these mollusks are subjected as those of a well-stocked reef of large brood-oysters. The condition of the industry, as indicated by this decreasing abundance and reduced size of the mollusks, the decreasing incomes of the fishermen and increasing prices of the oysters, demands the serious consideration of every well-minded citizen of Maryland, whether he be actively engaged therein or not. Already the price of the Chesapeake oysters is so high and the size so small that a number of Baltimore marketmen are required to purchase largely from other coastal regions, one firm alone in one year purchasing $70,000 worth of large oysters in Northern States.

The general assembly of Maryland has not permitted this condition to come about without endeavoring to prevent it; and the opinion, existing to some extent, that this State has exercised no care toward conserving and preserving her natural oyster beds, is without foundation in fact, for she has expended more effort than any other American State toward protecting and preserving the public reefs, to which may be due the fact that they are now in better condition than those in most other States. I believe that there has not been a single protective or restorative measure, giving assurance of benefit to the free or common fishery, adopted by any government in America or Europe, that has not at some time been operative in whole or in part of Maryland. From 1820, when "well-grounded apprehensions were entertained of the utter extinction of oysters in the State," up to the present time, by means of close seasons, interdiction of supposed injurious modes of fishery, and other restrictive measures, the State has constantly endeavored to conserve and protect the common fishery.

The stationary life of oysters, tending to facilitate their removal from the beds, is resulting in a depreciation of the free fishery in all civilized countries, notwithstanding severe protective laws, no community having yet learned the secret of preserving undiminished the prosperity of the public beds. It is to be regretted that no data are available by which to compare the extent of the common and private oyster fisheries. The growth of the latter during the last twenty years has been marvelous. At present scarcely one-half of the world's product of oysters is marketed directly from the public reefs, the quantity going upon the food market from Maryland being greater than that from all the remaining public beds of the world combined. Witnessing the continued depletion of their public reefs in spite of their protective laws, States and countries have grown weary of their task of attempting to preserve them and have encouraged the investment of private enterprise on barren grounds, making the regulations of the common fishery subsidiary thereto.* In Maryland, however, there are so many thousands of persons dependent on the common fishery, and its prosperity is so important a factor in the wealth of the State, that it has received every safeguard that presented a possibility of benefit, so far as the leaders in State legislation could conceive and carry out. And the regulations and sentiment that now surround the industry in Maryland are such that if ever the common oyster fishery on the public reefs becomes a thing of the past in America, I feel confident that its last battle ground will be along the shores of the Chesapeake.

The great trouble with the present methods and regulations is not with the close seasons or with the implements employed, but, as in other States, the oystermen take no individual interest in the preservation and development of the reefs on which they work, their sole object being to obtain at the moment all the oysters possible, without reference to the future supply. Individual interests clash with the public good. While it is the public or general interest of all that each oysterman should refrain from taking the small and poor oysters, take few during bad markets, and give attention to removing enemies and leaving the reefs in the best condition for further reproduction and growth, it is his individual but temporary interest to take all he can get, big and little, fat and poor, in good markets and in bad markets, and with the least possible expenditure of time. As with other men, the individual gain of to-day outweighs the public good of to-morrow.

An instance of the manner in which the public interest suffers at the hands of individual benefit may be cited in the cull law enacted in 1890, which required that all oysters measuring less than 2½ inches in length should, when caught, be returned at once to the water. It is generally admitted throughout the Chesapeake that could this regulation be enforced it would be more beneficial to the public reefs than any other oyster enactment ever made by the State. But as these small oysters, measuring from 1 to 2½ inches, are worth about 20 cents per bushel it is the temporary interest of each oysterman to sell them at the shucking-houses or for planting in other States, and as there are over 8,000 vessels and boats at work, it is obviously difficult for the fishery fleet to thoroughly enforce the law.

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*Many quotations similar to the following might be made from official reports:

"We find that the supply of oysters has very greatly fallen off during the last three or four years. That this decrease has not arisen from overfishing, nor from any causes over which man has direct control, but from the very general failure of the spat, or young of the oyster, which appears, during the years in question, to have been destroyed soon after it was produced. A similar failure of spat has frequently happened before, and probably will often happen again. That the best mode of providing against these periodical failures of the spat is to facilitate the proceedings of those individuals or companies who may desire to acquire so much property in favorably situated portions of the sea bottom as may suffice to enable them safely to invest capital in preparing and preserving these portions of the sea bottom for oyster-culture. * * * That no regulations or restrictions upon oyster fishing, beyond such as may be needed for the object just defined, have had, or are likely to have, any beneficial effect upon the supply of the oysters."—*Report of the commissioners appointed to inquire into the sea fisheries of the United Kingdom, 1866.*

Under the present regulations of the fishery the number of very small oysters (under 1 inch in length) destroyed frequently equals the number of large ones utilized. Attached to the shells of the large oysters will occasionally be found many small ones from 3 to 6 months old. As many as sixty of these young oysters have been found attached to the shell of a single mature one. This number, however, is very unusual, but the proportion for the entire bay might certainly be expected to average during most spawning seasons at least one or two young oysters for every mature one. These small oysters can not be utilized in the market-houses, and when delivered there are thrown upon the shell heaps. They have already passed through the most precarious period of their existence. Their shells have become sufficiently hard and stout to resist many of their enemies, and while some of them would doubtless perish if permitted to remain on the reefs, yet the mortality among them would scarcely be much greater than occurs among mature oysters. The remedy for their protection is not apparent. A careful oyster-culturist would doubtless postpone the taking of the mature oysters until the young ones were sufficiently developed to be safely removed from their attachment, but this course is scarcely practicable on the public domain without temporary close time on the reefs.

With respect to close seasons, which for forty years have been the most popular forms of protection in America, the close time in the fall is of value because of the protection it affords the small oysters from injury from the source above noted. But the opinion is growing among the best-informed persons that the spring close time is generally of little value to the reefs; in fact, under some circumstances it would be better for the oystermen to continue their operations to within a week or so of the spawning time. Their work would render the reefs more nearly free from sediment, vegetable growth, etc., thus facilitating the attachment of the spat.

The general opinion that the disturbing of mature oysters immediately prior to the spawning time greatly injures them has little foundation. To be sure, if oysters are removed from the reefs there are so many less to perform their reproductive functions, but the same applies equally to those removed eight months before. The action of the dredges themselves is not materially injurious to those oysters left on the beds. Naturalists are well aware that the most delicate ascidians are frequently roughly dredged, and if placed in a bucket of sea water may be examined in perfect health an hour or two afterwards; and it is scarcely probable that so hardy a mollusk as an oyster, capable of being kept barreled for weeks, shipped thousands of miles, and then bedded with perfect safety, would suffer so much injury from being jostled by the dredge as to fail in performing its usual functions. However, the spring close season in Maryland is deemed valuable because of its restricting the spring trade in small oysters for bedding purposes in other States, which, however, could be effected by the complete enforcement of the cull law. It is also of benefit to the agricultural interests along the shores in making labor more abundant.

There are other conditions that encourage a depreciation of the free fishery and for which the individual oystermen are not blamable. Among these might be mentioned an entire lack of care to leave the grounds or the small oysters in a condition suitable for the growth of the latter, and an absence of any attempt to prepare the beds for the attachment of a "set" during the spawning season. But everyone will recognize the extreme difficulty of devising a system for remedying the latter evil suitable for application over large areas of the public domain.

These two provisions—protection of small oysters and placing the reefs in the best possible condition for the attachment of a "set"—are the key-notes to the proper government of the fishery on the public beds, and any system of regulation that has not these for its objects can not be expected to be of great value.

It has been proposed that certain portions of the bay—half, for instance—be closed for two or three years in order that the oysters now thereon may have time to mature, and when this area is thrown open the other be closed for a similar period, the system of open and closed districts being continued indefinitely. But there are many objections to such a procedure. When the southern half is closed it works a hardship to persons living along the shores thereof, and when the fishery is interdicted in the northern half the residents in that vicinity would consider themselves aggrieved. If, in order to avoid this objection, the size of the districts be reduced and the number of them be multiplied, it would be quite difficult to prohibit the fishery in the closed ones. Also, it has been shown that the operations of the oystermen improve the beds for spat-collecting purposes, and a stoppage of the fishery might to a material extent affect the attachment of a "set."

It seems that the only good result of such a regulation would be a restriction in the removal of small oysters, but this would be secured under present regulations by a complete enforcement of the cull law. Were the system to be adopted, the enforcement of the cull law would still be necessary, and it would increase local jealousies, already too numerous, add another to the many regulations now difficult of enforcement, and yet be of questionable value.

If there were adopted a regulation for obtaining a "set," having among its features the return to the water of a portion of the shells accumulating about the shucking-houses, it seems possible that special benefit might result from this particular feature. When one considers that, as a component part of the oyster shells, 200,000 tons of carbonate of lime are annually removed from the Chesapeake, the question naturally arises as to the continuation of the supply. When returned to the water the shells rapidly disintegrate, furnishing material for the shells of other oysters. The benefits, if any, to be derived from such provision, however, rests entirely upon speculation.

An opinion is quite current that the proper regulation of the oyster fishery in Maryland is for the State to lease or sell the natural reefs and leave to the individual owners the question of protection or improvement of their respective holdings. Under the present condition of the industry and its environments it seems that such a procedure would be detrimental to the welfare and interests of those persons dependent on that industry for support, as well as to the peace and good order prevailing in the tide-water regions of Maryland. I believe that no American State, and certainly none in which the fishery is of great consequence, has ever deemed it expedient to dispose of the public interest in any natural oyster beds. The fishery in Maryland is not, as frequently supposed, a haphazard undertaking conducted by a class of men depending for success on violations of the State laws, but is on a firm, orderly basis, any sudden, revolutionary change in which would work great hardship and distress to the thousands of citizens depending on it for a livelihood

If the cull law be vigorously and thoroughly enforced, increasing the minimum limit to 3 inches as soon as the condition of the fishery may warrant, and a proper system be adopted for preparing the reefs for the attachment of spat during the spawning season, it is not probable that an extreme disaster to the industry will early ensue.

Barren bottoms.—It is claimed by many that the utilization for oyster-culture of extensive areas of ground now unproductive would add largely to the extent and revenue of the oyster industry in Maryland.

Of the water area of Maryland about 2,000 square miles is now unproductive of oysters. In 400 square miles of this the salinity of the water is probably not sufficient for the growth of these mollusks. A very large area of the remaining 1,600 square miles is covered with grass, thick mud, sand, or is otherwise incapable of utilization with profit under present financial conditions. The area of such ground is a very uncertain quantity. In Connecticut the experience has been that only one-fifth of the water area can be profitably utilized. But three-fourths of the unused ground is in the eastern half, where the barren condition is caused by heavy storms. Should a cultivating law be adopted in Maryland the crabbing interests would doubtless demand consideration and thus further reduce the possible area. All of these restrictions would probably limit it to from 400 to 1,000 square miles, if the conditions in other States are trustworthy guides.

It is unnecessary in the present paper to discuss the practicability of oyster-culture on areas not provided by nature with those mollusks, for this is no longer a living question, it having been answered years ago in many practical ways and in innumerable waters of varying physical and biological characteristics. Already only one-half of the world's product of oysters is marketed directly from the public reefs. At present the trade in high-grade oysters is dependent on the product of private areas, notwithstanding the slight encouragements received. Nearly every celebrated variety on the American market is the product of private grounds; among these might be mentioned the "Providence Rivers," "Norwalks," "Blue Points," "Maurice Coves," "Parker Bays," "Chincoteagues," "Cherrystones," "Lynn Haven Bays," "Hampton Bars," "Stone Bays," "Bayou Cooks," etc.

In hundreds of sheltered coves, and in much of the deep waters of Maryland where the bottom is muddy or grassy, or other conditions have heretofore prevented a growth of oysters, the difficulties might be overcome and the cultivation thereof be made profitable. The harvest is not always certain, but the chances are greatly in its favor, and the profits are sufficiently large to have merited more encouragement than has heretofore been accorded the industry. The situation of the Chesapeake, between the cold waters of the North and the warm waters of the South, protecting it from great extremes in temperature, is favorable to oyster-culture. Except in the extreme southern portion, this bay is also comparatively free from the severe storms and predaceous enemies that effect such enormous destruction on the oyster beds of Northern States.

Localities favorable to the development of oysters are not always best adapted to their reproduction, and places where oysters breed rapidly are sometimes not favorable to their growth. Generally the growth of oysters is practicable in waters having less saline constituents than appears necessary for breeding purposes. There is probably no locality of equal area in America, if in the world, in which oysters are produced in such numbers as on the flats on the sea side of Accomac and Northampton counties, Virginia; yet, if left on their native grounds, they scarcely ever exceed 2½ inches in length. The famous "Kettle Bottom" oysters of the Potomac River are of great size, but do not breed in abundance there. Under the present regulations in Maryland grounds suitable for the growth of oysters, but not adapted to their reproduction, are idle and barren, but under a planting system might be utilized with profit.

Suitable regulations for ostreiculture could be adopted which, without working change or injury to the present free fishery on the public reefs, would permit the development of this industry for the employment of the idle labor of the State. They should meet with the approval and have the encouragement of the present oystermen of the Chesapeake. The cultivating systems here outlined are by no means antagonistic to their interests; on the contrary, they more than any others are to reap the benefits. These men are familiar with the bay; they are familiar with the character of the grounds and with the methods of handling oysters; they are already fitted out with boats and implements for engaging in the business. They could acquire an area of ground which they could take pride in cultivating and improving, in adding to from year to year, and something on which they might depend in their old age.

There should be no fear of outside capitalists, monopolies, etc. There has probably never been an instance in which, after a State has adopted a cultivating law, the trade has been controlled by men from other States, if any attempt has been made to prevent it. On the contrary, in New Jersey, New York, and Connecticut many of the men who at present own the large oyster farms, the fleets of vessels, and employ the greatest number of men, were formerly public-reef tongmen and dredgers. The members of a certain firm in Connecticut, who in six weeks gathered from its beds 160,000 bushels of oysters valued at $110,000, were public-reef oystermen eighteen years ago.

There is no warrant for concluding that the most extreme protective or restorative regulations that the State could adopt would preserve the common fishery from depletion to such an extent that there will be scarcely a subsistence for the men engaged therein. Numerous acts of assembly exist for protecting the oyster fishery on the public reefs of the United States coast north of Cape Cod, but not an acre of oyster-ground now remains to give operation to those regulations. The fishery from Cape Henlopen to Cape Cod has had even further restrictions, but at present scarcely one-twentieth of the 7,000,000 bushels of oysters produced annually in that region are marketed directly from the public reefs. France has witnessed the depletion of certain of her valuable reefs even when the fishery thereon was restricted to fourteen days in the year and three hours in the day. Already distress exists at times in several isolated localities in Maryland, because of the decrease in prosperity of this industry, and this is possibly a foreshadow of what will, in course of time, prevail in every tidewater region of the State if the present unfavorable conditions of the fishery continue without the possibility being given the oystermen for adding to their incomes by the investment of individual enterprise. Other than this no prospect appears for a great improvement in the condition of the fishermen, and the only heritage they now have to leave their sons is contained in their small boats and a training for engaging in a vocation already barely affording a livelihood and with a prospect of continued decrease.

But the benefits to be derived from a proper system of private oyster-culture would not be confined to those persons engaging in it or to those handling the products of the private areas, or to the increased amount of money disbursed along the shores. If the common fishery were still properly protected and regulated, private ostreiculture on present barren bottoms would, it seems, be of benefit to the public reefs and to the men operating thereon, even though the latter should never engage in growing oysters for themselves. The foundations for this statement are here cited:

1. It is well known that the removal of medium-sized oysters to more favorable feeding-grounds on which they may remain several months greatly increases their

market value, and if a planting industry were established the small or poor oysters would find a much better market among the planters than at the shucking-houses. The oysters referred to are those measuring 2½ inches and over, for it is assumed that no change will occur in the present regulations of the common fishery so far as the cull law is concerned.

2. The cultivators would doubtless remove predaceous enemies from their areas and this would decrease the number left to feed on the public reefs.

3. If by reason of fishery or natural effects the oysters on a public reef should be so fully removed or destroyed as to not leave sufficient for breeding purposes, the proximity of private oyster beds would supply the deficiency in spat.

4. By engaging the attention of a number of the oystermen it would to some extent relieve the public reefs of the extensive fishery to which they are now being subjected and leave a greater quantity of oysters for those persons continuing to resort to those areas.

Ostreiculture in some States has to contend with an adverse movement brought on by its supposed friends rather than its enemies. The profits of few vocations have been so extravagantly represented as those of the one under discussion. The enthusiastic amateur agriculturist who writes on "5 acres enough," has his counterpart in the field of ostreiculture. Reports evidencing great labor in preparation have gravely predicted an average annual product in Maryland of hundreds of millions of bushels of oysters under a wise system of regulations. The adoption of a system of oyster-culture dependent for its success upon the realization of such expectations would doubtless result in failure. The conditions of aquiculture in this country, or in any other country, do not warrant such anticipations, and they have done much to retard the adoption of a practicable system of regulation for private oyster-culture in many States. These extravagant ideas of production are not understood by the bay men, and their acceptance by persons unfamiliar with the growth of oysters leads to a difference of opinion which can be reconciled only when the truth of the subject is understood. It has resulted in the development of the feeling that the present barren bottoms are of enormous value, and should be parted with only at prices so high that persons of small resources can not obtain them, and renders the development of extensive ostreiculture thereon impracticable.

It is questionable whether there is a single square mile of water area in America that has produced annually during the last ten years 400 bushels to the acre. It is true that there are many planting areas from which even 1,000 or more bushels to the acre are annually removed. But the oysters are not produced there; being obtained elsewhere, they are bedded in the spring and are taken up during the succeeding winter. They are little more the produce of those areas than are cattle slaughtered in abattoirs the product of the few acres of grazing land attached thereto.

The system of private oyster-culture at present practiced in Connecticut is admired by every one familiar with it. It has resulted in creating a new industry for the employment of capital and labor, in distributing $1,000,000 annually among the workmen along the shore of that State, and extending and cheapening the food resources of the country. Yet the average annual yield of the 60,000 acres held by individuals is only 25 bushels per acre. About one-half of this area, however, is not utilized, and the cultivated portion yields annually about 50 bushels per acre. The tax imposed by that State is about 10 cents per acre, and should this be increased to the figures proposed for adoption in some States, it would doubtless at once result in a great reduction in the extent of the industry, notwithstanding the fact that it is now on a well-established basis.

Frequent reference has been made to what is being accomplished in Rhode Island in the collection of an annual rental of $10 per acre from certain sea bottoms, and this is used as a basis for the valuation of similar areas situated elsewhere. There are about 600 acres of ground in that State rented at this rate. They do not produce oysters but are used for planting purposes, the oysters being bedded in the spring and removed during the succeeding winters. Because of the high rental, little attempt is made towards the production of oysters, the plants being purchased from other States, and even the extent of the bedding trade is said to be curtailed thereby, it now being less than one-half as extensive as it was in 1880. It is true that the State treasury has received about $6,000 annually, but if the taxes on the ground had been more reasonable Rhode Island might at present have sufficient oyster-producing farms to keep within that State the $150,000 annually paid by the planters therein to the oyster-growers of other States, and to cause the receipts of the State treasury to equal those of the present.

The imposing of high taxes on oyster-grounds renders it financially impracticable to utilize them for any purpose other than the bedding of oysters, shifting them from one locality to another, which is not true oyster-culture.

In an address delivered at Baltimore January 18, 1891, the following expression of opinion was made by Hon. Marshall McDonald, United States Commissioner of Fish and Fisheries, who has given close attention to aquiculture in all its branches:

> In the case of that broad area of sea bottom which at present yields nothing to production, it would, in my judgment, be wise on the part of the State to permit its entry under conditions similar to those which are prescribed for the public lands of the State above tide.
>
> The man engaged in oyster production should be harassed by no imposts or special supervision. He should be treated as is the farmer, protected in his rights of property, and his investment required to bear equally with the lands above tide the burdens of taxation. The State should seek to derive its revenue not from any special tax or from extravagant prices for sales or entry, but from the vastly increased valuation which would be given to these lands when the opportunity for their improvement is afforded.

There is a greater area of sea bottom in the United States suitable, if properly prepared, for the growth of oysters than any probable market demand can utilize. The Atlantic coast States are wealthy in barren sea bottoms available for the culture of oysters, but most of these States are so neglectful of giving proper encouragement to the development of them that only in few places are they of great financial value. A broad system of ostreiculture demands more facilities than a restriction to 5 or 10 acres along the shore at high rental and with temporary tenure.

Not only does successful ostreiculture require sufficient areas on which to operate, but it must be surrounded with favorable market and financial conditions. Texas, with its characteristic generosity, authorizes each citizen of the State to preëmpt for oyster-culture 60 acres of sea bottom without cost and without taxes, yet not one-hundredth of its bay bottoms are being so utilized. In 1889 North Carolina threw open to her citizens 800,000 acres of barren ground under favorable preëmption conditions, yet only one-thirtieth of this area has been located. The condition in Georgia is much the same. The Middle and New England States, with long-established oyster trades, have been more successful in having their sea bottoms preëmpted and successfully utilized.

The physical, financial, and market conditions in Maryland are such that judicious encouragement could almost at once place her in the head ranks of oyster-cultivating States; order and industry would spring up where there is now but a barren waste; thousands of men now almost idle could be given employment; relieving the labor market of this surplusage would benefit the laboring classes in all industries of the State; while the oystermen at work on the public reefs, without being in any respect molested in their present occupation, would have an opportunity for building up a kindred industry to add to the support obtained from the common fishery.

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Constituting an appendix to the preceding are the following two articles:

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Extracts from report of Francis Winslow on investigations of oyster beds in Tangier and Pocomoke sounds and parts of the Chesapeake Bay. pp. 105-219.

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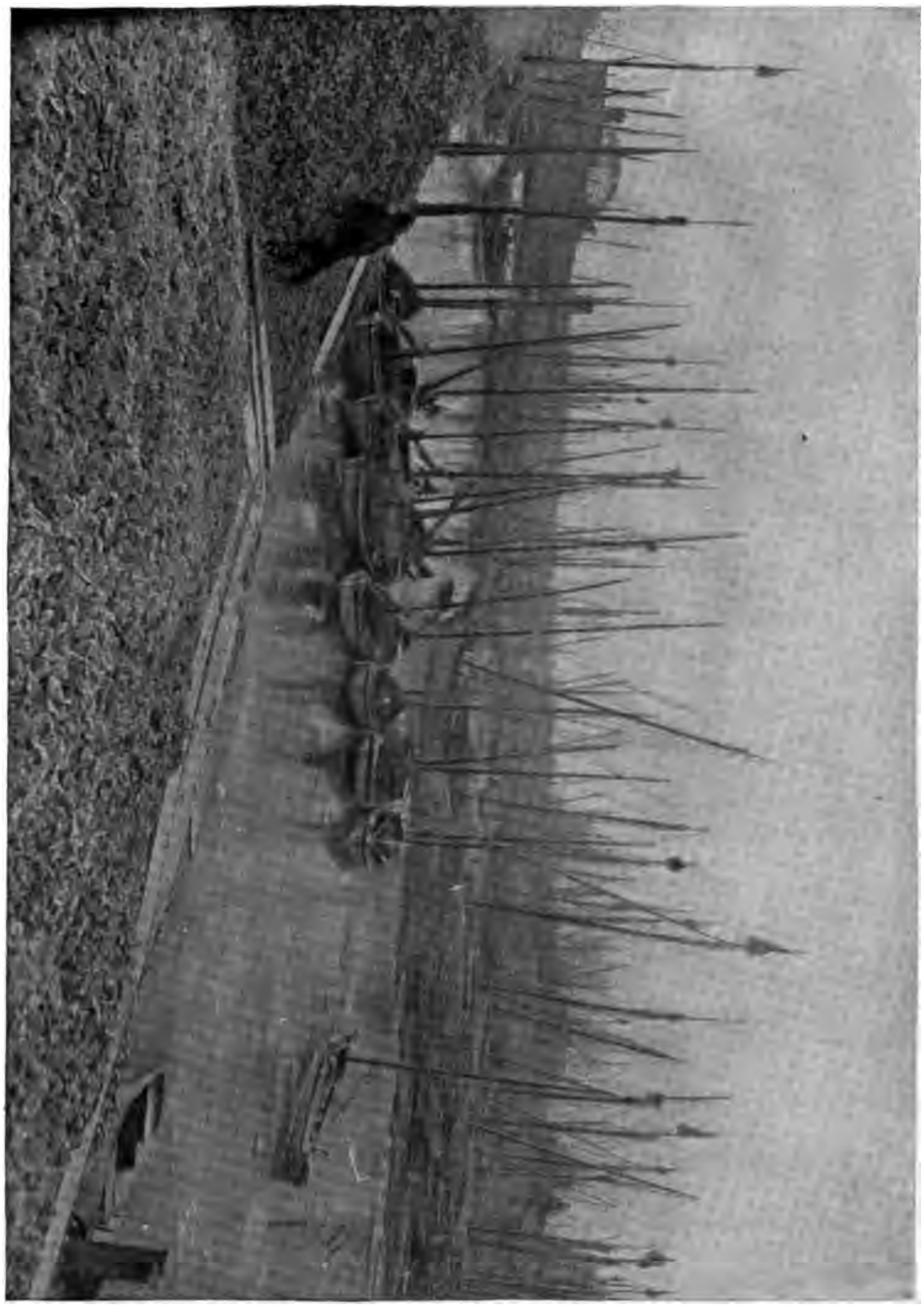
1893—Maryland—its resources, industries, and institutions. Prepared for the board of World's Fair managers of Maryland by members of Johns Hopkins University and others. Baltimore, 1893. The oyster and the oyster industry, pp. 264–312.

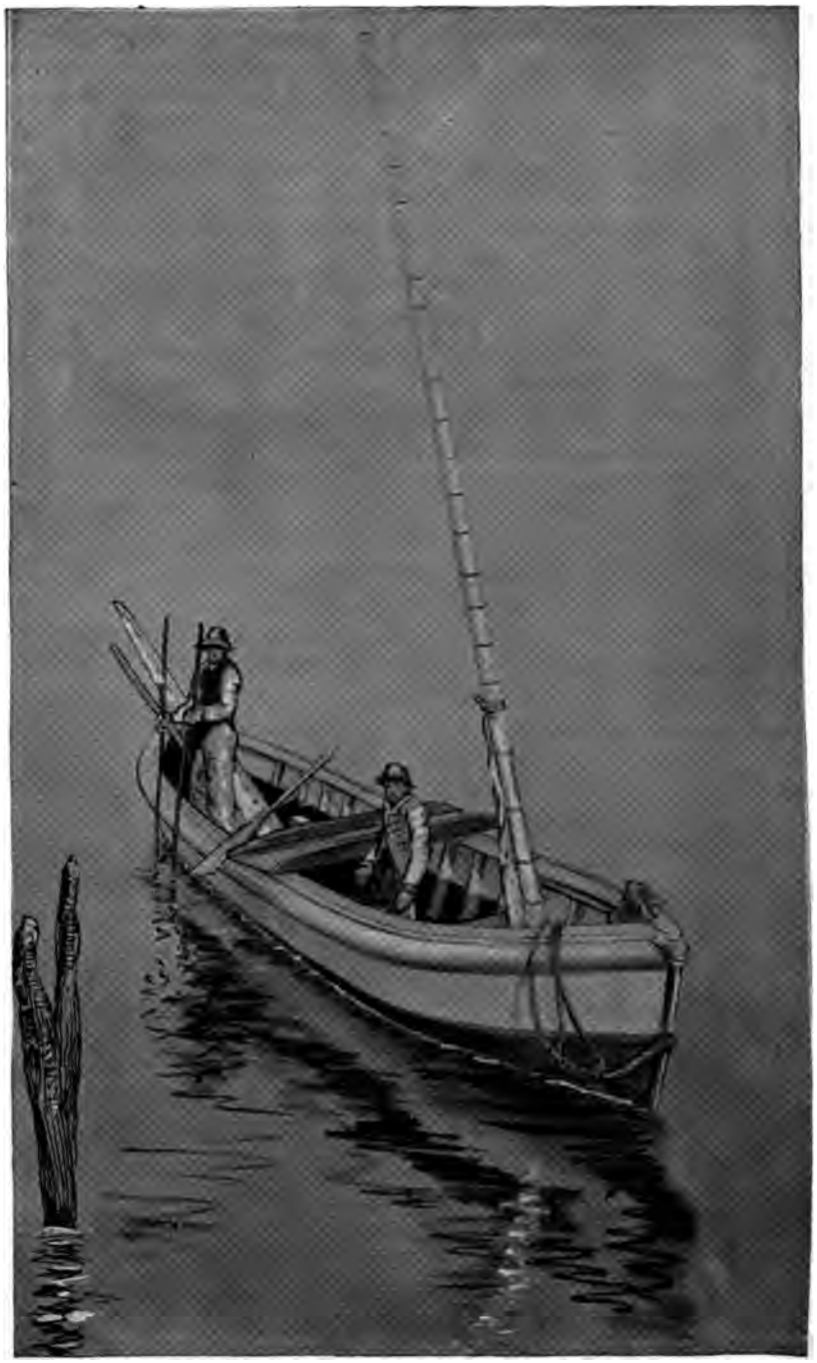
1893—"Oysters and roads." Address delivered by B. Howard Haman before the Maryland convention for good roads, held at Baltimore on January 12, 1893. Printed by order of the Maryland road league. 8vo, 24 pp., with chart.

Bull. U. S. F. C. 1892. Oyster Industry of Maryland. (To face page 298.)

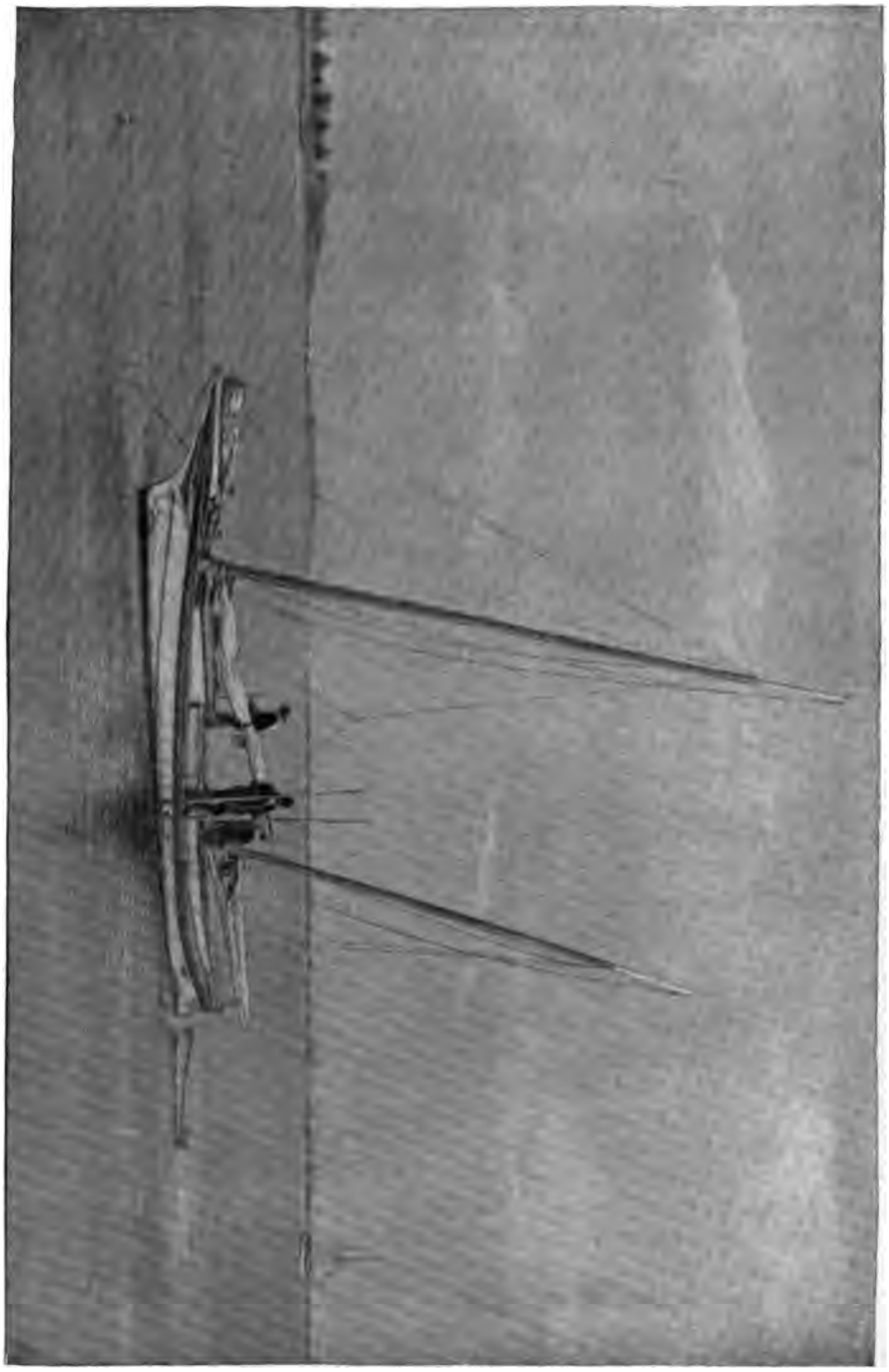
PLATE LIX.



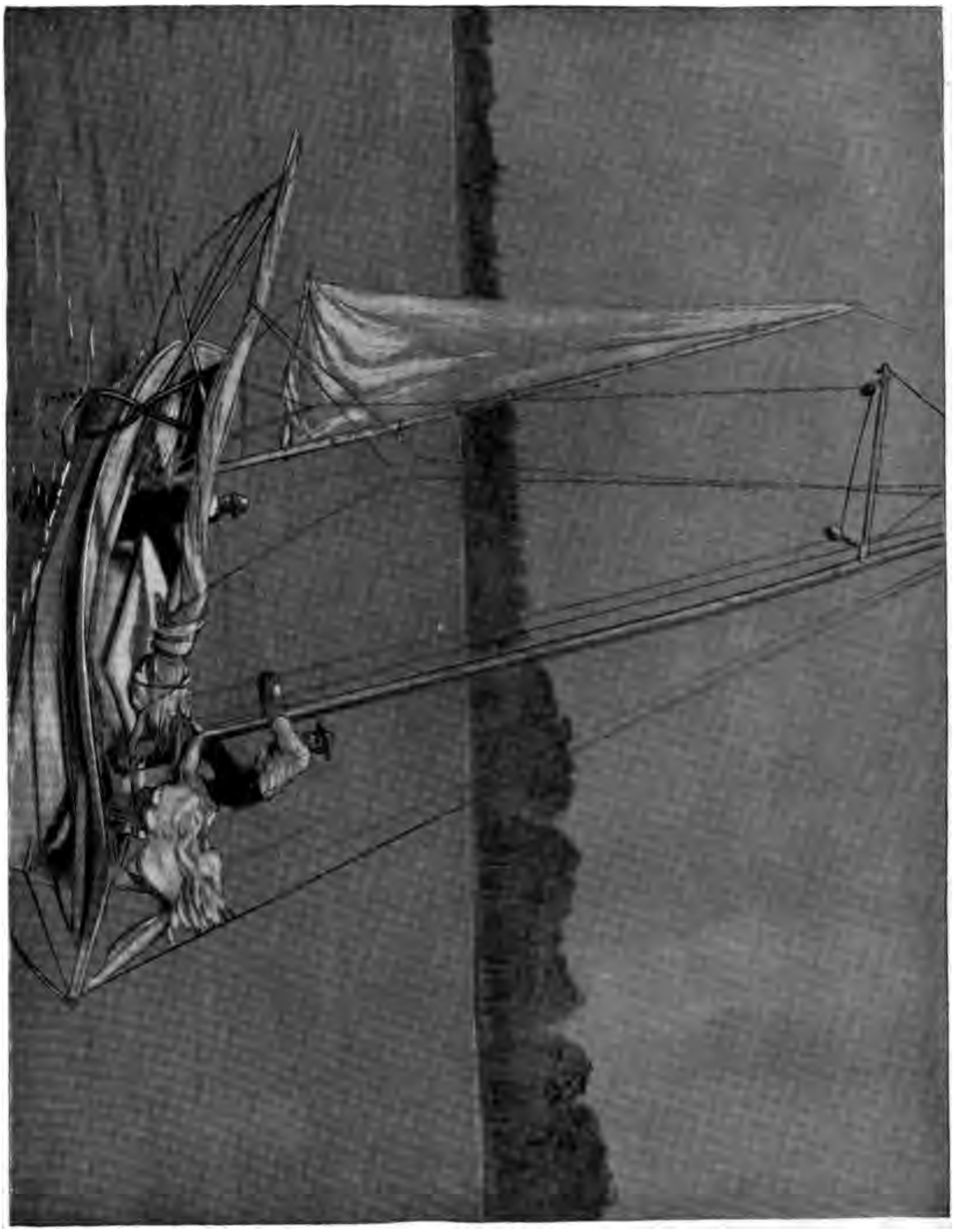
OYSTER VESSELS AND BOATS FROZEN-UP AT A MARYLAND OYSTER PORT.



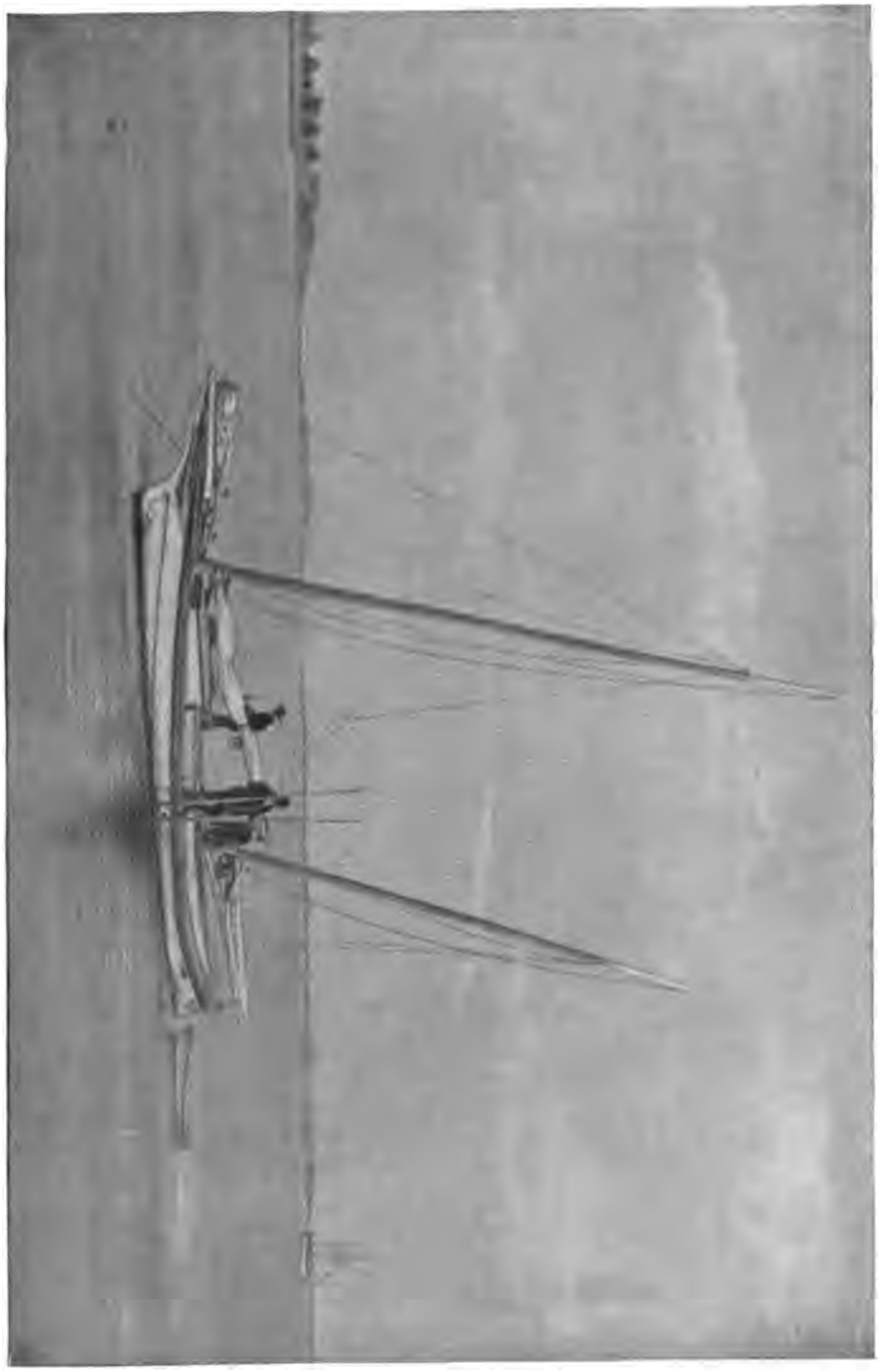
CHESAPEAKE BAY TONGING CANOE.



CHESAPEAKE BAY TONGING BUG-EYE, WITH SHAFT TONGS.



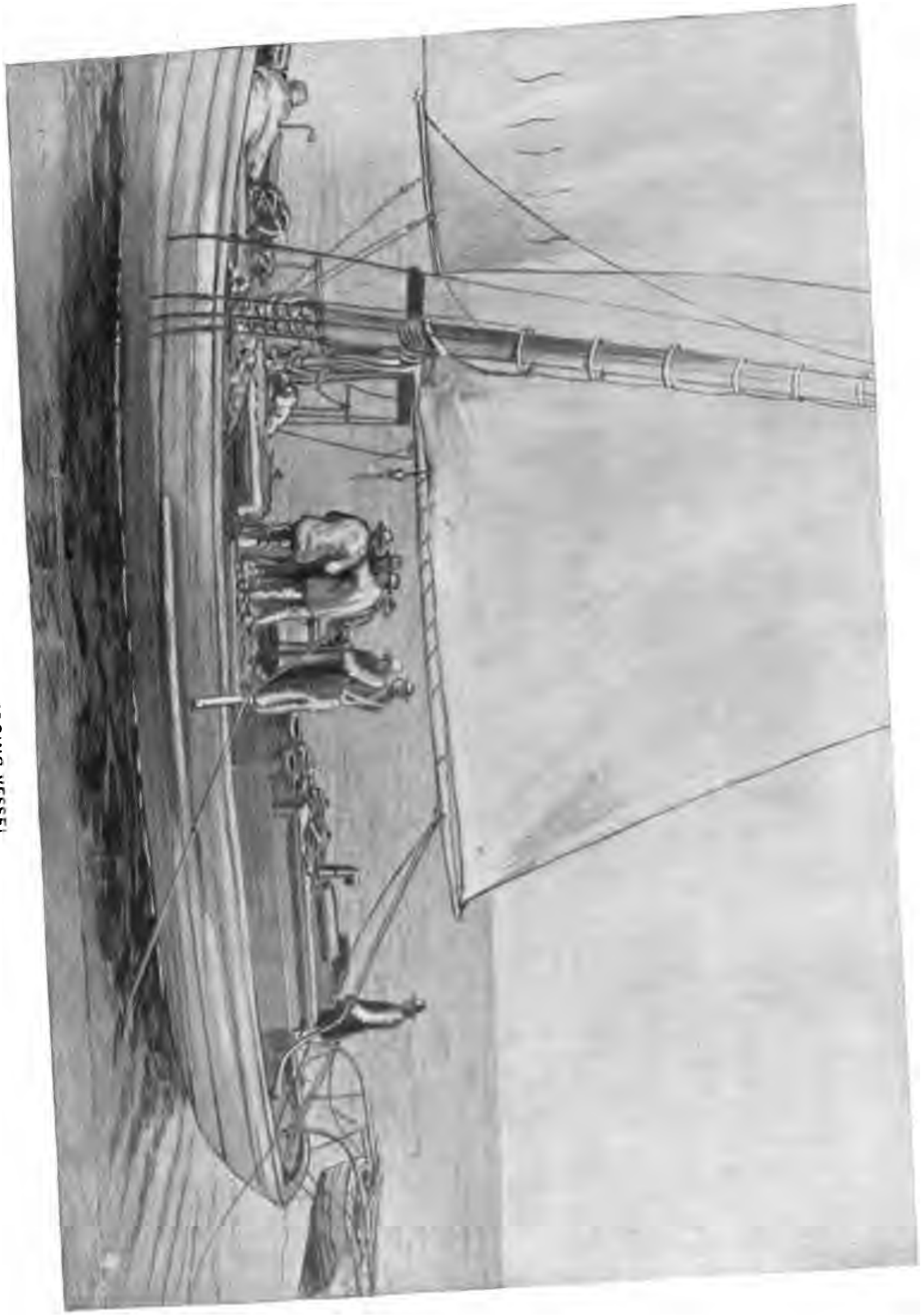
CHESAPEAKE BAY TONGING BUG-EYE, WITH DEEP-WATER TONGS.



CHESAPEAKE BAY TONGING BUG-EYE, WITH SHAFT TONGS.

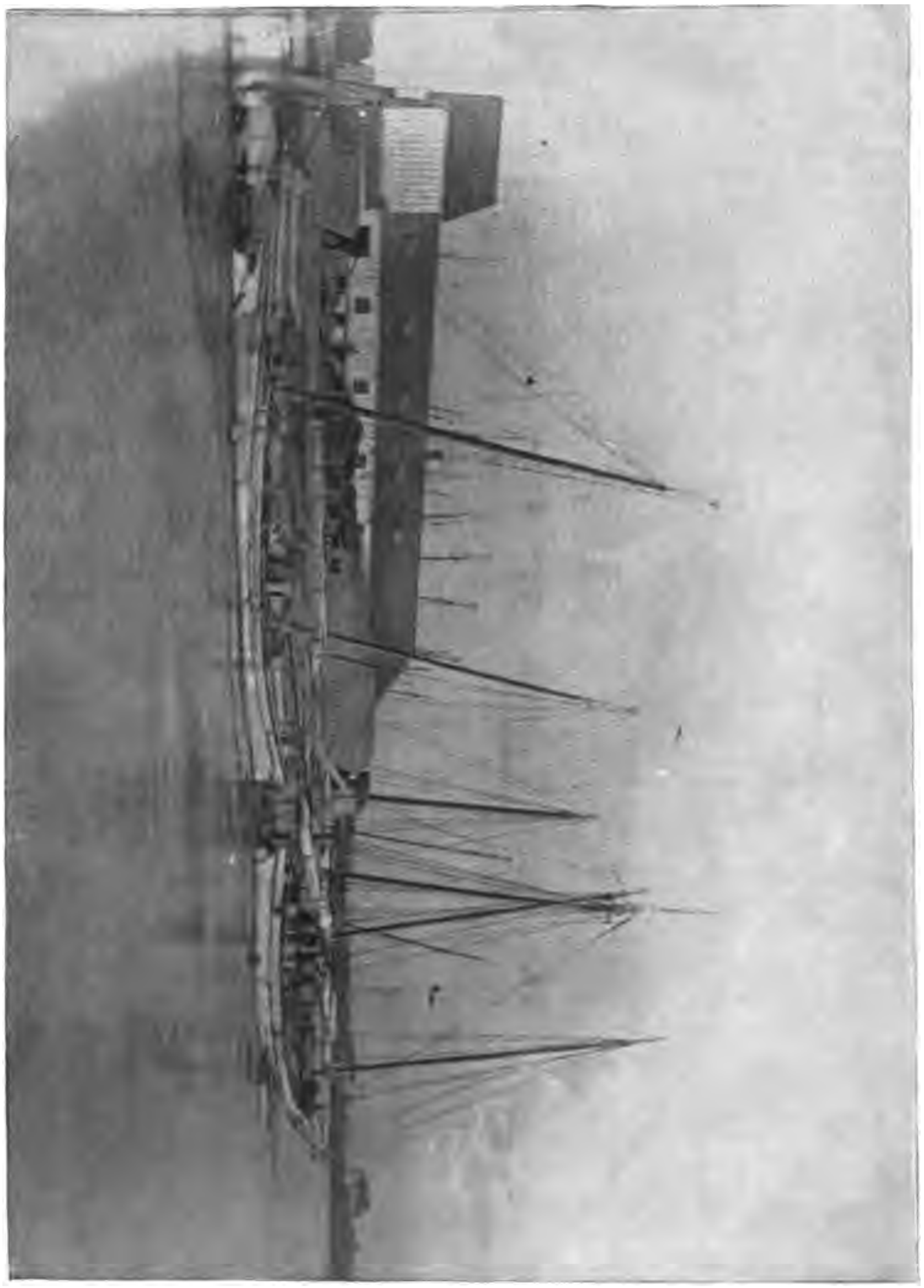
Bull. U. S. F. C. 1892. Oyster Industry of Maryland. (To face page 298.)

PLATE LXIII.



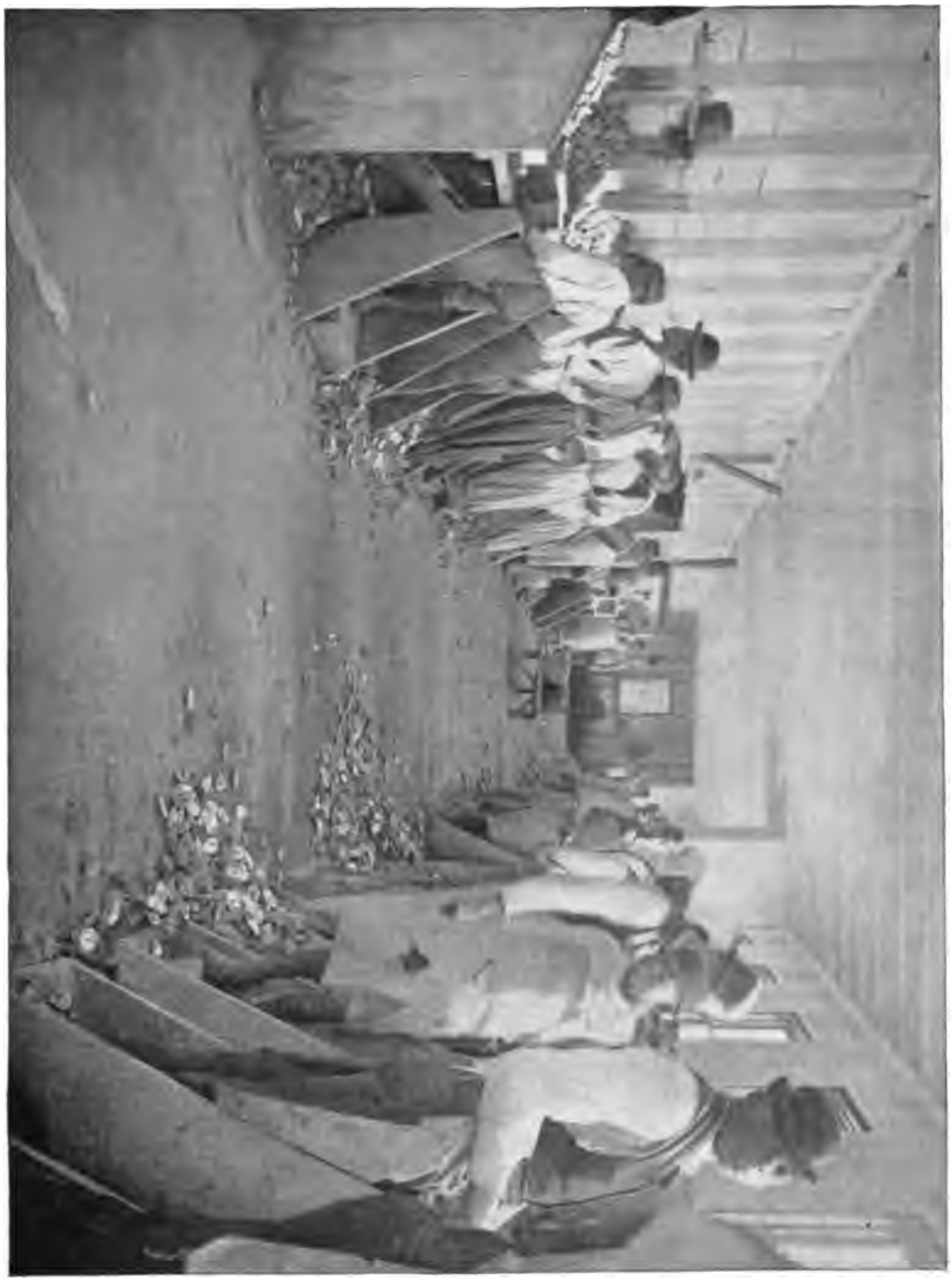
CHESAPEAKE BAY DREDGING VESSEL.

PLATE LXV.

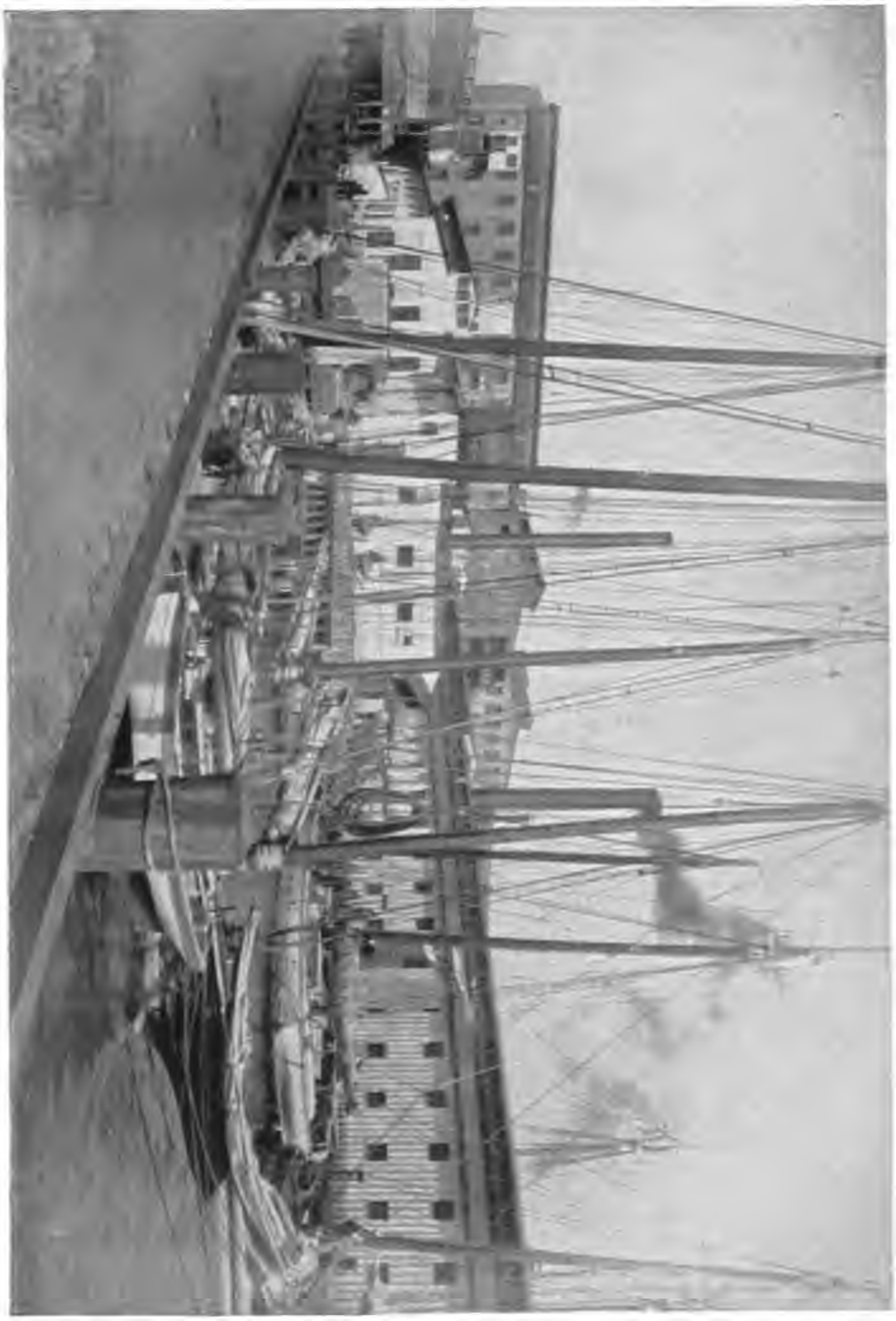


OYSTER-SHUCKING ESTABLISHMENT AT ONE OF THE "DOWN-THE-BAY" MARKETING PORTS.

PLATE LXVI.

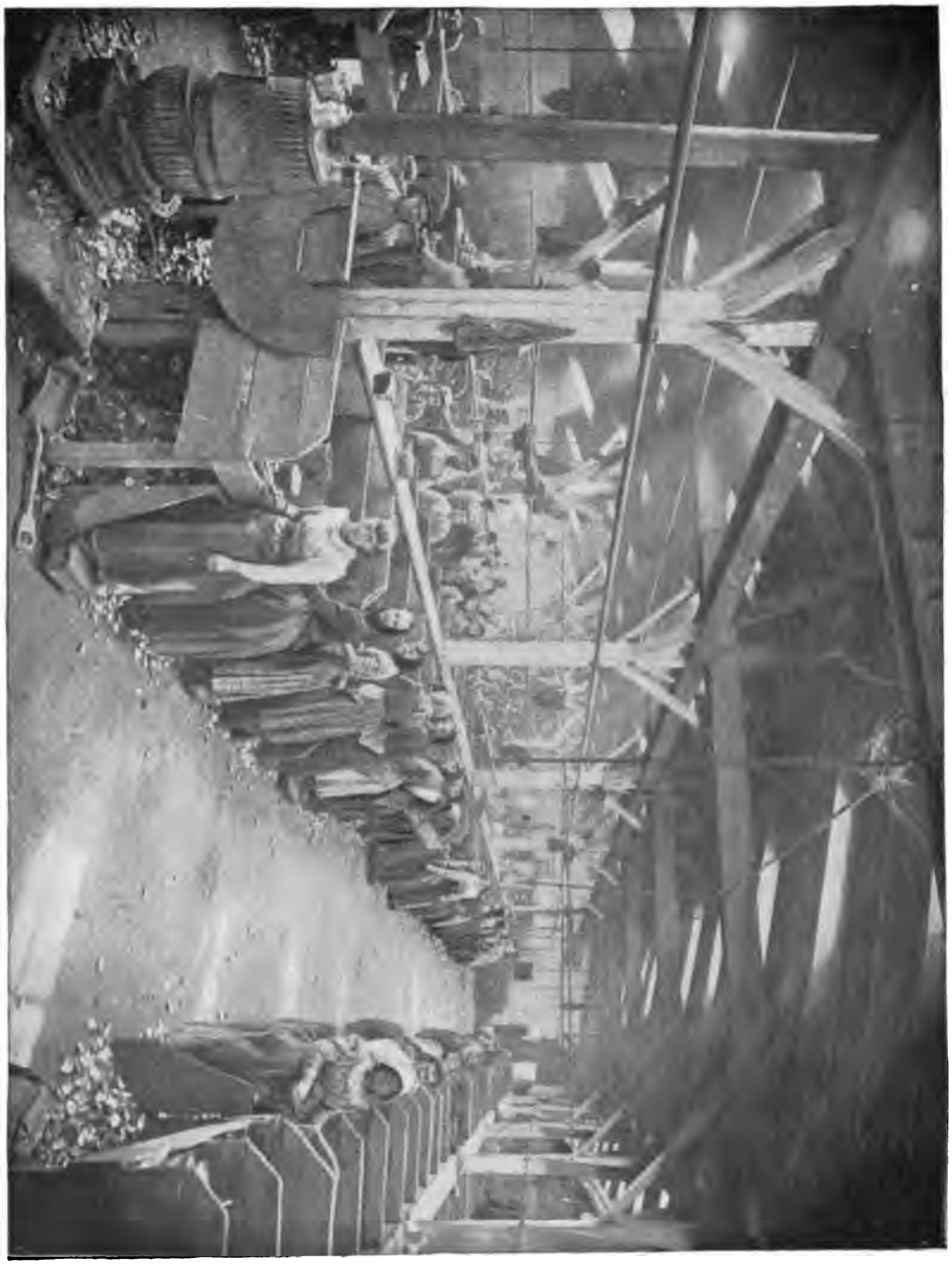


INTERIOR VIEW OF A "DOWN-THE-BAY" SHUCKING ESTABLISHMENT.



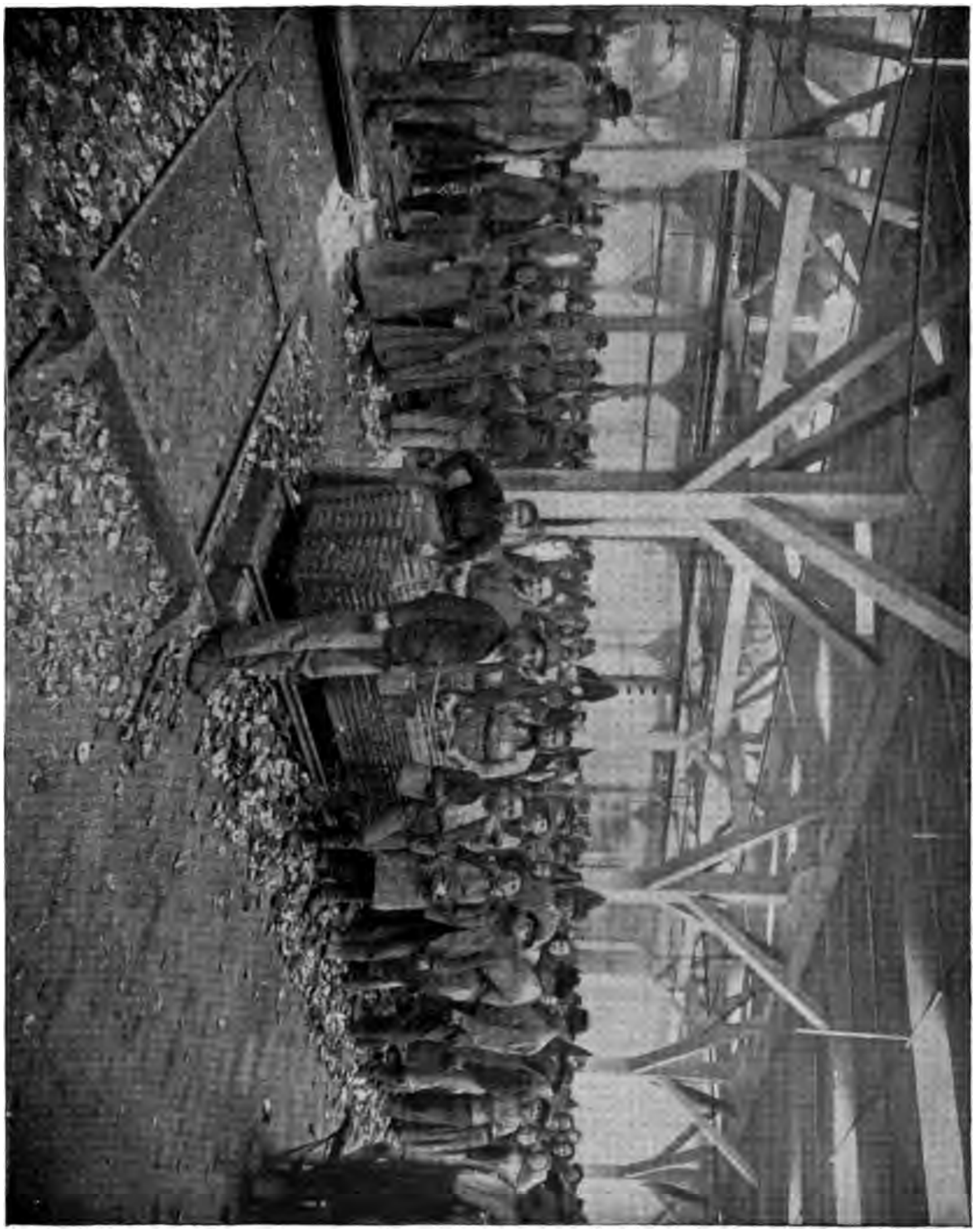
OYSTER-MARKETING ESTABLISHMENT AT BALTIMORE.

PLATE LXVIII.

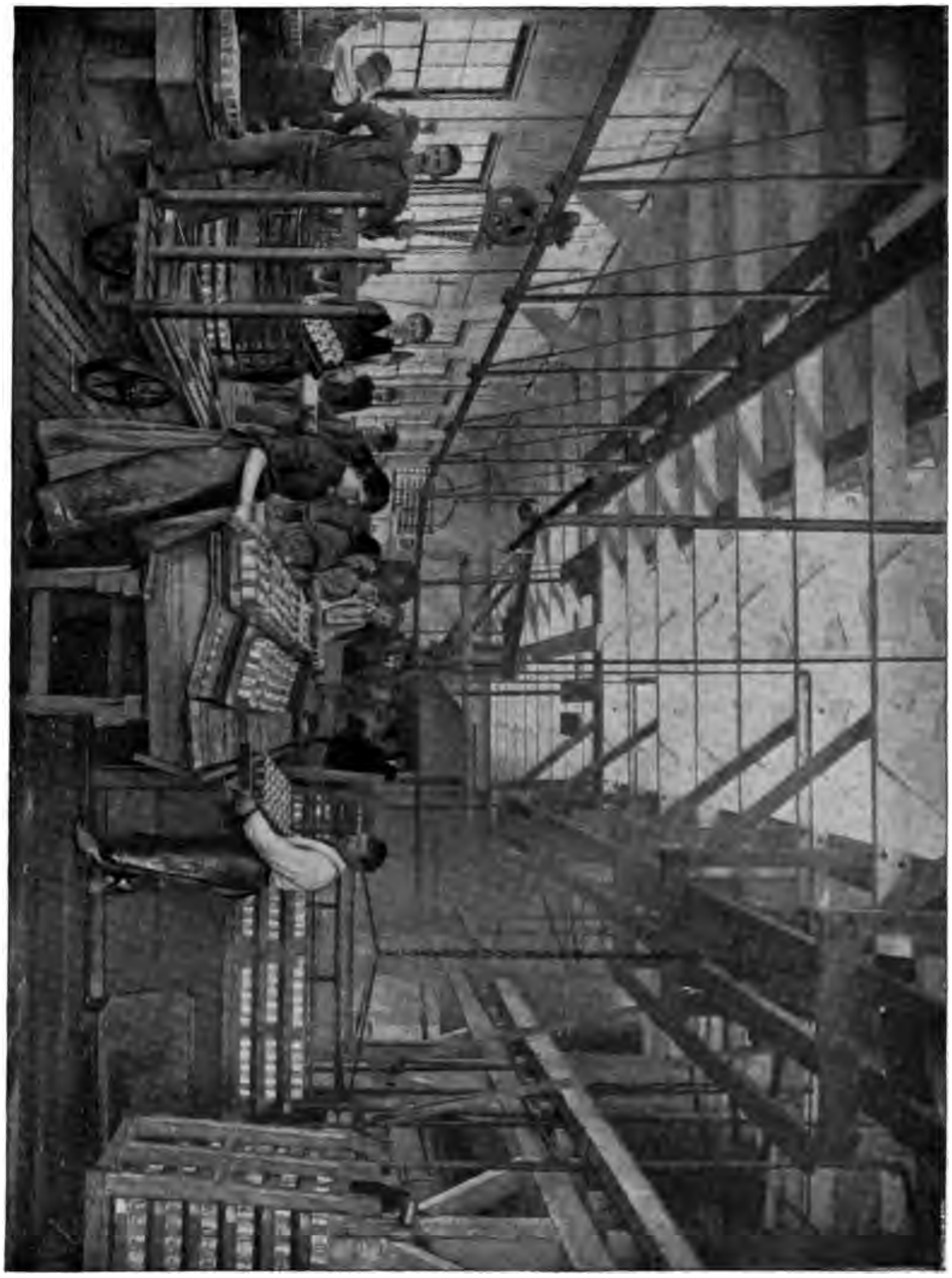


SHUCKING ROOM OF A BALTIMORE MARKETING HOUSE IN THE RAW TRADE.

PLATE LXIX

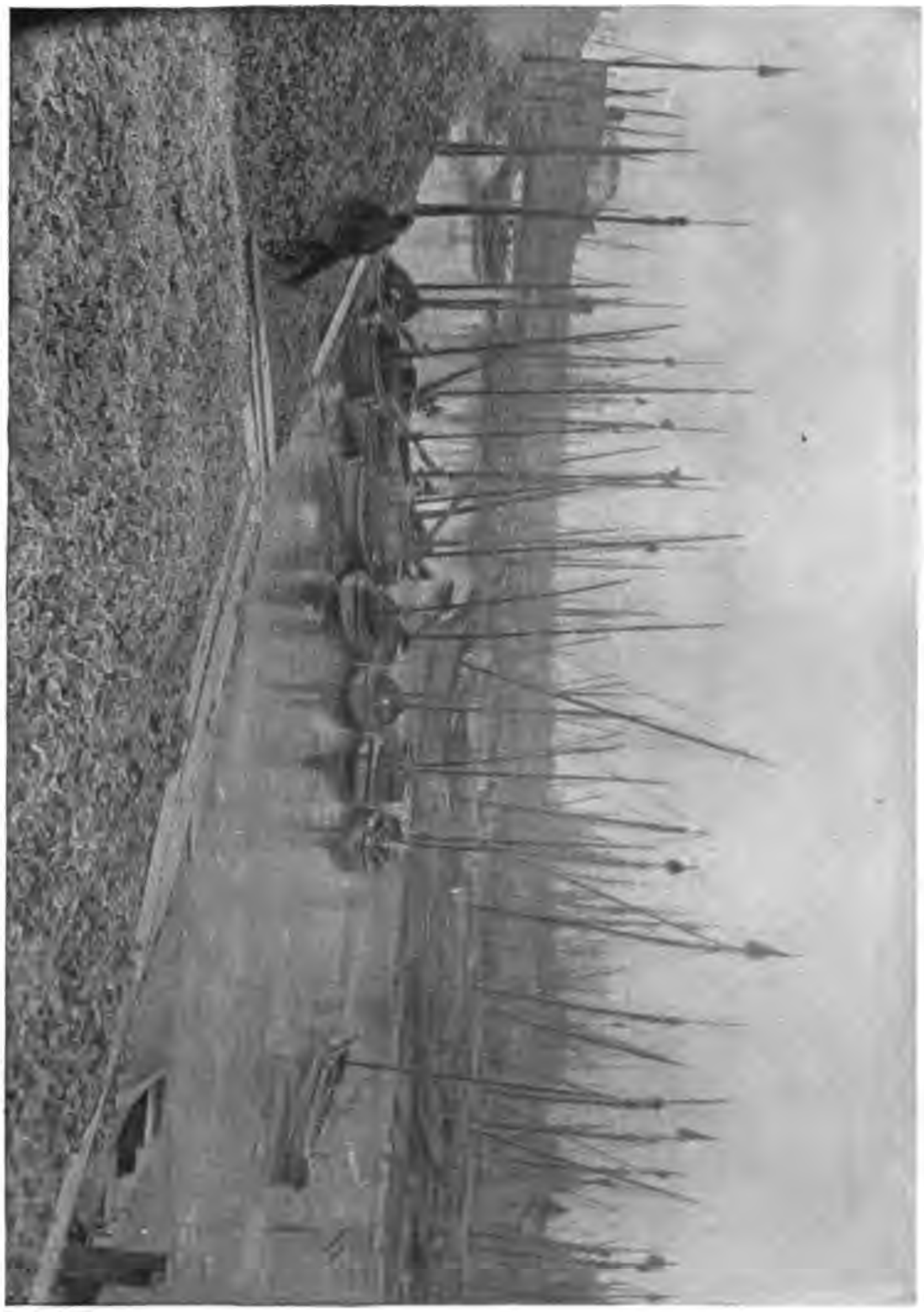


SHUCKING ROOM OF A BALTIMORE OYSTER-CANNING HOUSE.



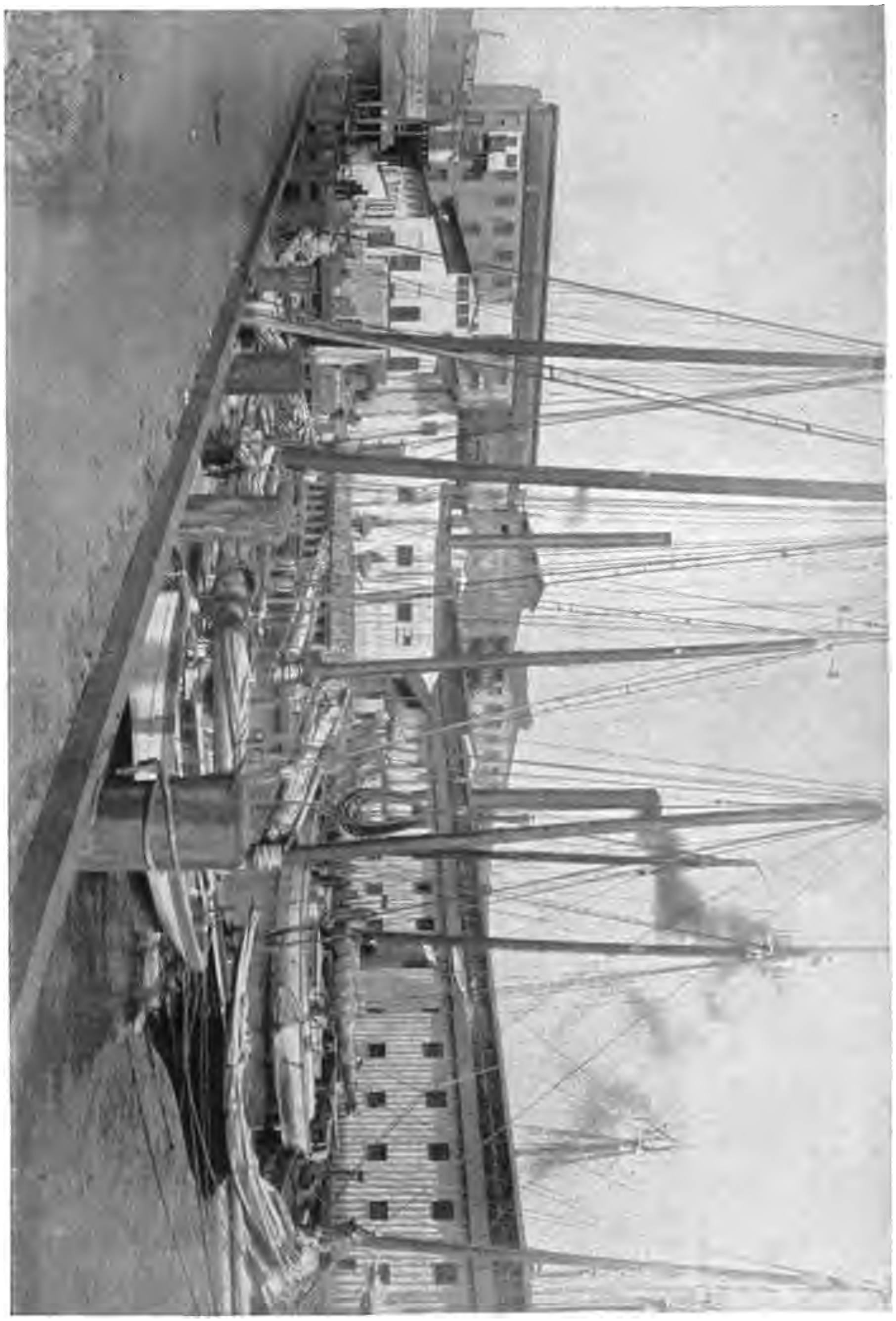
PROCESSING ROOM OF A BALTIMORE OYSTER-CANNING HOUSE.

PLATE LIX.

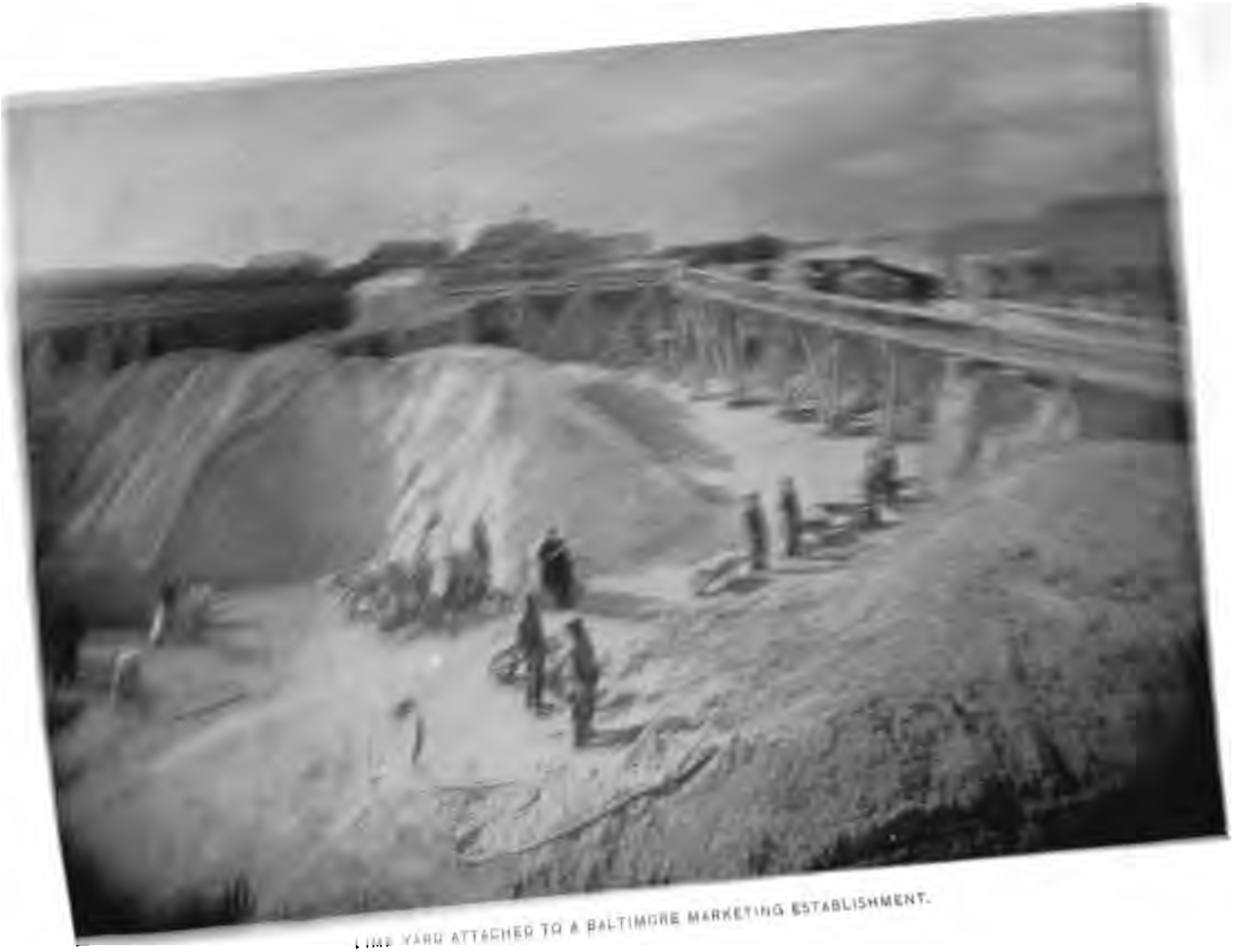


OYSTER VESSELS AND BOATS FROZEN-UP AT A MARYLAND OYSTER PORT.

PLATE LXVII.



OYSTER-MARKETING ESTABLISHMENT AT BALTIMORE.



LIME YARD ATTACHED TO A BALTIMORE MARKETING ESTABLISHMENT.

are provided with one or two wings, which may be used with or without leaders. When a leader is used it very often does not extend from the shore. The reference to "outer openings" in the definition quoted is not clear; a typical fyke net has only one outer opening, and the hoop on which it is formed may be from 1 to 15 feet in diameter. There is no limit to the number of funnels, from one to five often being used. All the hoops may be of the same size.

As a result of the researches made by the writer and a study of the forms of fyke nets used in this and other countries, the conclusion has been reached that the designation fyke net should be reserved for that form of fish trap characterized by a bag-shaped inclosure, made of netting, distended at its mouth by a hoop, the opening into which consists of a funnel-shaped aperture; that all other features are secondary and do not determine whether a given apparatus is or is not a fyke net, although a style so simple as that defined is rare.

The forms of apparatus to which the fyke net is related are various. On the one hand are some types of lobster and eel pots, baskets, and other similar traps provided with a funnel-shaped entrance, but usually made of laths, splints, or casks and having no accessory leader or wings, and on the other hand are varieties of trawl nets, bag nets, and similar closed nets that may be distended by means of one or more hoops but have no funnel-like aperture. An examination of any of these nets will usually show the essential features by which they are distinguished from the fyke. The intergradations, however, between fyke nets and some types of pots and traps are such that it is not always possible to properly characterize some of the more aberrant forms. In the present paper it has been considered desirable to class as fykes certain nets that are ordinarily designated pots.

NAMES OF THE FYKE NET.

This net is generally known throughout the United States as the fyke or fyke net. The name appears to have arisen from the Dutch word *fuik*, and was doubtless introduced by colonists from the Netherlands, where it is or was applied to a form of net constructed of hoops or of bowed twigs. The usual spelling of the word in early writings is "fike."

The name "hoop net" is also used in parts of this country—most frequently in the Great Lake region. In Great Britain this is the designation generally employed. "Stationary hoop net" also appears to have had a local usage in New York in the early part of this century, but has not recently been met with.

In the Hudson, Delaware, Potomac, and other rivers of the East Coast fishermen often refer to the fyke as a "pike net." Although the pike (*Lucius reticulatus*) is often caught in this way, it seems probable that the name is a corruption.

A number of other names with a more or less circumscribed habitat have been met with, and there are doubtless others that have not been recorded. "Buckdart" and "sink net" are heard in certain parts of Chesapeake Bay. In Saginaw River, Michigan, fyke nets are known as "gobblers." Nets that resemble pound nets in having leaders and curved wings are in parts of Virginia called "funnel-mouthed pounds."

The name bow net, of which fyke net is said in the dictionaries to be a synonym, has not been met with in this country, although it may nevertheless be used. The name bow net, as employed in the fisheries of the United States, is, so far as known, applied only to the dip net and the skim net.

Various qualifying names are applied to fykes in different localities, depending on peculiarities of construction, the fish and other products caught, etc., as "pound fyke," "drop fyke," "shad fyke," "eel fyke," "terrapin fyke," and other designations which will be referred to under each State.

This net is usually known as the hoop net in Upper Canada and as the fyke net in Lower Canada; by the French inhabitants of Canada it is called the *verveux.*

In the countries of northern continental Europe the name applied to the fyke net is the equivalent of the English word *rush*, and refers to the material of which this or similar nets were originally constructed. The word can evidently be traced to the Goths, in whose language it appeared as *raus*, while in Anglo-Saxon it was *risk*, and in modern times it exists as *reuse* and *fischreuse* in German, *rüse* in Low German, *ruse* in Danish and Norwegian, *rysja* in Swedish, *rysä* or *ryssä* in Finnish, and *versha* in Russian. These names are used alone or in connection with other descriptive words. In Prussia the name *fischsack* is applied to a typical fyke net having wings.

In the fisheries of the Adriatic sea the fyke net is known as the *cogolo*, and forms an essential part of a number of fishing devices, some operated like seines or beam trawls and others stationary.

The Portuguese name for fyke net is *botirão.* A form of fyke resembling an eel pot is called a *muzuar.*

Fykes in France are known by a number of names. The most commonly used designation is *verveux* or *vervier*, equivalent to the English hoop net; *guideau* is a modified fyke; among other local names are *loup*, *renard*, *quinqueporte*, *queue*, *manche*, *sac*, and *cache.*

THE PRINCIPLE OF THE FYKE NET.

The fyke net, as used in this country, is a passive form of apparatus of capture, the principle of whose action depends on the funnel-shaped entrance. The fish, led to the mouth of the net by various devices, pass through the funnel into the body of the net, and are usually unable to escape owing to the narrowness and position of the aperture. In the efforts to escape, the fish go through the remaining funnel or funnels and ultimately congregate in the last pocket, from which they are taken at intervals.

The fyke net has been aptly compared in its action with one of the common mouse or rat traps in which the animals caught are retained alive. The principle has a wide application and at the present time is extensively employed in nets used for the capture of various animals. In the fisheries it is seen in the pound net, lobster pot, eel pot, trap net, some forms of weirs, etc. It finds a varied representation in the fishing devices of many countries, particularly in China, where it is applied to a great variety of nets, some constructed of twine, others of bamboo splints.

The action of the fyke net is facilitated by the well-known habits of most fishes when in a confined space—an apparent aversion to make a sharp turn and a tendency to wander around with their heads closely applied to the netting, by which they are led into the succeeding funnels and seldom brought near the only possible way of escape suspended in the middle of the compartment.

CLASSIFICATION AND DESCRIPTION OF FYKE NETS.

There is perhaps no type of fishery apparatus employed in the United States that presents more varied shapes and peculiarities than the fyke net; and a collection of fyke nets drawn from the various countries of the world would perhaps be the most heterogeneous aggregation of related fishing appliances that could be brought together. The differences in form arise from variations in the shape of the individual parts and in the arrangement of the parts with reference to each other. Among the principal causes which have produced the widely divergent styles the following may be mentioned:

(1) The nature of the fishing-ground, the depth of the water, the character of the bottom, the direction of the tide or current, and the contour or structure of the shore are modifying influences.

(2) The kinds of fish or other animals sought. A net adapted to the capture of one fish is often of little service in taking another species.

(3) The idiosyncrasy of the fishermen. Being a comparatively cheap and uncomplicated form of apparatus, the ingenuity and inventive genius of the fishermen have an opportunity to assert themselves and are no doubt to be credited with many of the peculiar types in local use.

In the accompanying descriptions, the following parts of fyke nets will be mentioned, which may here be briefly defined:

The net proper.—This includes all the essential parts of a fyke, and is referred to in contradistinction to the accessory parts, such as the leader, wings, lines, anchors, etc. It is variously known as the bag, pocket, bowl, and pot. The names pot and bowl are sometimes restricted to the final apartment of the fyke in which the fish usually congregate and from which they are taken; this is also called the tail. It is usually closed by means of a cord known as the purse string or puckering string.

The hoops.—These constitute the framework of the bag. They are usually made of flat wooden strips, but are sometimes of iron. They are generally round, but are sometimes elliptical; in some forms of nets one or more semicircular hoops are used, and in a rare style of fyke the part which corresponds with the first hoop is rectangular. The number of hoops used in this country varies from 2 to 15, the most common numbers being 3 to 6. The first hoop is usually larger than the others, but in some nets all are of the same size. There is a great variation in the sizes, the extremes being 8 inches and 15 feet; a large majority, however, are from 2 to 6 feet in diameter. They are held in place by being included within the meshes of the bag.

The funnels.—These, known also as throats or valves, are the characteristic parts of a fyke. They consist simply of cones of netting, one end of which is attached to the hoops while the other end is suspended from them. The size of the funnels bears a close relation to that of the hoops; the entrance into the funnel is usually the same size as the hoop; the small end of the funnel varies from a few inches to a foot in diameter, depending on the kinds of products taken as well as on the general size of the net. The number of funnels varies; some fykes have a funnel to each hoop; in some there is a funnel for every alternate hoop, while a single funnel is found in a few nets. The purpose of the funnel is to prevent the escape of the fish, and the greater the number of funnels the less the chances are that an animal will find its way out of the net. The length of the funnels usually corresponds with the distance which the hoops are apart; in some types, however, the funnels extend through 3 to 5 hoops.

The lea[illegible]—The leader, hedging, or fence, as it is variously called, is employed for the purpose of intercepting the passage of fish and of directing them into the net. It is generally constructed of netting, but is sometimes made of brush, stakes, slats, or wire. When of netting, the mesh is larger than that used in the pocket. The length of the leader varies with circumstances, and may be from 10 to 500 feet. It usually extends, in a straight line from a point on or near the shore, at right angles to the supposed direction taken by the fish.

When the leader is constructed of netting it is usually provided with floats and sinkers to keep it in an upright position, and is further supported by being attached to one or more poles, the number depending on the length of the leader. The leader may terminate before reaching the fyke proper; in nets provided with wings, this is generally the case. It may also be attached to the top and bottom of the first hoop. In some nets, for instance those used in Germany, the leader extends a considerable distance within the cavity of the net.

The wings.—The wings are usually two in number, but in some nets there is only a single wing. They are attached to the first hoop, each wing being fastened to half the circumference of the hoop. In some cases the wings are joined together at the top and bottom for a short distance in front of the bag, forming a kind of cylindrical entrance. When used alone they serve the same purpose as the leader; when employed in connection with the latter, their action is supplemental to it. They are similar to a leader in construction. Their shape varies; straight, angular, curved, and irregular shapes exist.

A clearer idea of the variations in the styles of fyke nets employed in the United States is conveyed by the accompanying plates than could be imparted by text descriptions. Nevertheless, mention of certain details of construction, cost, etc., is necessary in order to properly cover the subject, and a number of forms not figured are described.

For the purposes of this paper, fyke nets may be classified into (1) nets having no leader or wings, (2) nets having only a leader, (3) nets having only wings, (4) nets having both leader and wings, and (5) double nets and irregular forms.

FYKE NETS WITHOUT LEADER OR WINGS.

The simplest form of fyke which would be covered by the definition given is the Chinese net illustrated in fig. 1, plate XCI. It consists only of a bag, a single hoop, and a funnel. No fyke so simple as this has been met with in this country. Fyke nets not provided with a leader or wings are not widely used in the United States; in fact, they seem to be almost restricted to the Middle Atlantic States, where they are known as drop fykes, brook fykes, or pike nets, and are extensively used in the upper waters of the principal rivers. In this class are also to be included certain pot-like fykes, mostly intended for eels, and fished in various parts of the country, but mostly in the New England and Middle States.

A form of brook or drop fyke used in the Delaware River has 11 to 14 hoops, varying from 14 to 18 inches in diameter and placed in the bag at intervals of 6 to 8 inches. It is provided with two long funnels, one extending from the first hoop to the fourth or sixth hoop, the other beginning where the first ends and running through about half or two-thirds of the remaining hoops. The funnels do not terminate in round apertures, but in four points, from which as many strings pass through the remaining part of the net and are collected and held taut outside the last pocket. The fish are taken from the nets by first unfastening the funnel lines at the end of the net and then raising the fyke perpendicularly, when the funnels will be reversed and the fish will fall out. This net is inexpensive, costing only from $3 to $5. It is fished singly or in strings containing 25 or more nets, which are placed at distances of 6 to 40 feet. Plate LXXIII, fig. 1, gives an idea of one of these nets and the method of weighting it with stones.

Another drop fyke, or "pike net," as it is locally called, fished in the Delaware River, has a semicircular entrance instead of a circular one; in other respects it is similar to those already described. One form has only one funnel, or "throat," however. The bar forming the bottom of the first hoop projects a few inches on either side for the reception of a stone, by which the net is kept upright, after being braced at the small end. The value is the same as the others, viz, $3 to $5. Plate LXXII is a representation of this net. The specimen from which the drawing was made came from Burlington County, N. J., and is now in the possession of the writer. It has 8 hoops and 2 funnels. The first funnel extends from the second hoop a short distance within the third hoop, where it terminates in four points which are kept open by means of double strings running to the fifth hoop. The second funnel extends from the fifth hoop into the space between the sixth and seventh hoops; it ends in the same way, and the four cords which hold the mouth of the funnel open are brought together outside the pocket. The net presents the following additional features:

Extreme length	inches	62
Height of entrance	do	17
Width of entrance at base	do	36
Diameter of second hoop	do	11
Diameter of last (eighth) hoop	do	9½
Size of mesh between first and second hoops	do	1
Size of mesh in bag and funnels	do	⅝
Diameter of mouth of first funnel	do	4
Diameter of mouth of second funnel	do	2½
Weight of net	pounds	2

Large fykes of this class are reported to be used in the rivers, creeks, and bayous of the southwestern States for buffalo-fish. These fish have regular "runs," and the nets are placed so as to intercept them in their movements.

One of the most novel forms of fyke nets of this class which has been met with is a device patented in 1844. It is shown in plate LXXIII, fig. 3. It consists of 17 hoops and 4 funnels, and has two small suspended compartments in which live bait is placed to lure the fish. It is not known that the net was ever employed for commercial fishing, and it seems to have been more of a curiosity than a practical device. The description furnished by the inventors is as follows:

> The nature of our invention consists in dividing a cylindrical net into different compartments and furnishing each with a bait bag, the bait being suited to the different kinds of fish, and the large fish being prevented from entering the compartment of the smaller ones.
>
> Its construction is as follows: A cylindrical net is formed in the ordinary way and of the required length. The first compartment, *A*, is formed of large meshes. It is distended with a series of circular hoops, *a a*, the first one, a^1, being a *D*-shaped one for the entrance into the net, within the mouth of which, from the second hoop backward, there is a funnel-shaped gorge, *b*, which gradually contracts toward the inner end conically, where it terminates in a small aperture, which is kept distended by cords, *c*. Within this there is a similar-shaped entrance, *d*, and at the termination of the first division there is a division, *e*, stretched across, of the same large-size meshes as those of the net, and attached to the hoop, a^2. Between the second funnel, *d*, and the division, *e*, there is a small cylin-

drical net, *f*, distended with hoops and having very small meshes. This is closed at both ends and is fastened in the center of the large net. It is for the purpose of containing bait, which can be kept alive therein. From the partition, *e*, the net is continued on, and kept distended similar to the first compartment, forming another compartment, *B*, which, after reaching the first hoop, a^3, is made with smaller meshes. At this point it has a funnel, *g*, similar to those in the first compartment, and behind it is a second bait bag, *h*, in all respects like the first.

The compartment, *B*, is terminated by a partition, *i*. The same-sized mesh, or larger, is continued on to another hoop, a^4, from which the meshes are fine enough to hold small fish for bait, and this part, *C*, is furnished with the usual funnel-shaped mouth, *k*, and its end is terminated by a cord, *l*.

A net constructed after the above plan will serve to catch salmon, etc., in the first compartment, from which eels and smaller fish will be driven out; but they have free access to the next compartment, where they are caught, while bait fish enough to supply the two first may be obtained by the last compartment, in which something may be placed to attract them.

Having thus fully described our improvement, what we claim therein as new and desire to secure by letters patent, is—

1. The combination of a series of compartments in the manner and for the purpose described.
2. The combination therewith of the bait bags, as herein specified.*

Several forms of small cone-shaped nets, used chiefly for eels, are to be classed with the foregoing fykes.

Plate LXXIV, fig. 1, represents an eel fyke employed on the Atlantic coast. It is constructed partly of wire and seems to be a simple fyke of this class. The body is made of fine wire, supported by two broad flat wooden hoops at either end of the net. A twine funnel guards the mouth of the net, and another one begins about the middle of the barrel; four stout cords proceed from the ends of the funnels to the sides of the net, the place of their insertion being reënforced by an extra wire. The end of the trap from which the catch is taken also consists of netting provided with a pursing string. This fyke is 3 feet long and 10 inches wide. It is known as an "eel bait pot," in allusion to the fact that it is baited for the purpose of attracting the eels.

Several forms of nets of this character not provided with leader or wings have been ascertained to exist in other countries. They will be referred to in some detail in the chapter on foreign fyke nets and need only be briefly mentioned in this place. One style of pot-like fyke has 3 hoops of equal size and a straight funnel extending from each end occupying about three-fourths of the length of each half of the net. The specimen figured (plate LXXXIX, fig. 2) represents such a net used in Prussia, where it is called a *bollreuse* (round fyke). A somewhat similar trap used in France, with the funnels extending obliquely into the bag and reaching beyond the middle of the net, is shown in plate LXXXIV, fig. 2. A Portuguese net, with 5 hoops supporting a bag of the shape of a truncated cone, having a single funnel at the entrance and terminating in a door, through which the fish are extracted, is exhibited in plate LXXXIX, fig. 3. Similar nets of this class that partake more of the typical nature of a fyke are employed in Portugal and France.

FYKE NETS WITH LEADER.

Very few fyke nets having only leaders are used in this country. The form is much less efficient than that provided with wings alone, or with both leader and wings, and probably this fact, as much as anything else, accounts for the scarcity of this style, both in number and variety.

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*Invented by John Carr, Jackson Shannon, and William Carr, of Sunbury, Pa. Letters patent No. 3741, dated September 14, 1844.

Fyke nets with leaders and without wings are usually set in pairs at the ends of a common leader, the entrances to the nets facing each other. Such an arrangement has been met with in the James and York rivers, Virginia, and is considered very satisfactory in the capture of striped bass. The nets are usually placed parallel with the shore, often off the mouth of a creek or cove. The nets observed have three hoops, the first of which is 4 to 6 feet in diameter, the last 1½ feet in width; there are two funnels. The length of each bag is about 12 feet. The bag and funnels are made of netting with a 1-inch mesh. The leader is from 25 to 40 fathoms in length. A set of two nets, with the intervening leader, is worth from $30 to $50.

Two nets of this class employed in Europe are figured (plate XC, fig. 1, and plate LXXXIX, fig. 1). One, used in Portugal, consists of a simple bag, with one hoop and one funnel weighted and buoyed; the leader is relatively short and extends from an abrupt wall. The other, a Norwegian net, resembles the form already mentioned set in the United States, consisting of a net at each end of a common leader; it has 3 iron hoops of uniform size (2½ feet in diameter) and 2 funnels provided with wire apertures. Similar nets, with 5 wooden hoops of unequal sizes and 2 funnels arising from the first and third hoops, are also met with in Norway. The leader in examples inspected is about 50 feet long and is provided with cork floats and earthenware sinkers; it projects for a short distance within the cavity of the first funnel.

FYKE NETS WITH WINGS.

Fykes provided only with wings are somewhat common in certain parts of the country. This is the form usually supplied by the net companies, and, according to Mr. W. S. Shepard, of the American Net and Twine Company, Boston, Mass., is sold ready-made in a great variety of sizes, the diameter of the first hoop varying from 1 to 8 feet. The following table of descriptions and prices of nets having one and two funnels is extracted from the catalogue of the net company named; the prices include two 12-foot wings. Mr. Shepard, who has courteously furnished some interesting notes and sketches of fyke nets, remarks of those under consideration that "they are used in taking all kinds of fresh-water fish in rivers and fresh-water ponds and lakes, and are also largely used in shore fishing both on the Atlantic and Pacific coasts for fish that follow along close to the shore."

Single-throat fykes.					Double-throat fykes.				
Diameter of large hoop	Length of net.	Size of mesh.	Size of twine.	Price complete.	Diameter of large hoop.	Length of net.	Size of mesh.	Size of twine.	Price complete.
Feet.	*Feet.*	*Inches.*	*Thread.*		*Feet*	*Feet.*	*Inches.*	*Thread.*	
2½	4½	1	9	$6.00	2½	6	1	9	$7.00
3	5½	1	9	6.50	3	7	1	9	8.00
2½	4½	1½	9	4:00	2½	6	1½	9	5.00
3	5½	1½	9	4.50	3	7	1½	9	5.50
2½	4½	2	9	3.00	2½	6	2	9	4.00
3	5½	2	9	3.50	3	7	2	9	5.00
3½	6½	2	9	4.00	3½	9	2	9	5.50
4	7½	2	12	6.00	4	10½	2	12	8.00
5	9	2	15	8.00	5	13½	2	15	10.00
6	11	2	15	10.00	6	16½	2	15	12.00

A winged fyke, used in considerable numbers for taking eels, especially in Massachusetts, is illustrated in plate LXXIV, fig. 2. The barrel of the net is about 18 inches in diameter at its mouth and is set at the bottom of the junction of two diverging wings which are 6 to 8 feet deep.

An extensively used winged flounder fyke is peculiar in having elliptical hoops, four in number, with a single funnel. The long diameter of the first hoop is usually 36 inches and the short diameter 18 inches.

A fyke net of this class, used on the eastern shore of Maryland and elsewhere in Chesapeake Bay, is known by various names, and applied to the capture of various products. A common form, in use in Dorchester County, Md., and fished for terrapin, striped bass, and perch, consists of a bag 18 feet long, distended by three hoops, 6 feet apart; the first hoop being 8 feet in diameter, the second 6 feet, and the third 4 feet. Funnels proceed from the first and second hoops. The wings (locally called leaders or hedgings) are 30 to 60 feet long. A similar type, with wings 18 feet long, is known as a "sink net," on the Nanticoke River and elsewhere, and is set under the ice for striped bass and perch. Another style, with three funnels, shown in plate LXXIII, fig. 2, is called a "buckdart," in Fishing Bay, Md., and is there employed exclusively for terrapin. A fyke net with three semicircular hoops and two funnels and two short wings, known as a drop or brook fyke, is reported to have been recently used in the Delaware River, in shallow water. It had a value of $5 to $10.

FYKE NETS WITH LEADER AND WINGS.

Fykes of this class are among the most numerous, varied, elaborate, and efficient nets employed in our fisheries.

The simplest fyke of this style has an ordinary leader and two straight wings, as shown in plate LXXV, fig. 2. It is a common net in many places, and in certain parts of the Chesapeake Bay is the predominant one. The example figured, from Queen Anne County, Md., may be described as follows: The length of the net proper is 12 feet. There are five hoops, with two funnels extending from the first and third hoops; the first hoop is from 5 to 8 feet in diameter. The wings are 36 feet long, and the hedging is 40 yards long. The value of such a net is $8 to $15, depending on the newness of the materials used. Similar nets in the same region are 14 to 18 feet long, with leader from 40 to 100 yards in length. Rarely the hedging is constructed of laths nailed on crosspieces supported by uprights. These nets are adapted to the capture of striped bass, yellow perch, catfish, alewives, pike, and terrapin.

Numerous fykes of this class are employed in the Hudson River and on Long Island. They have rather short leaders (called "fences") and wings, and from two to four hoops. They are designated two-hoop, three-hoop, and four-hoop fykes. They are adapted to the capture of all kinds of river and shore fish. The approximate measurements and cost of the various kinds are as follows:

Kind of net.	Length of leader.	Length of wings.	Diameter of hoops.				Cost.
			First.	Second.	Third.	Fourth.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Dollars.*
Two-hoop fyke	10 to 15	4 to 6	2 to 3	1½ to 2	....	....	5 to 10
Three-hoop fyke	10 to 25	6 to 8	3	2 to 2½	1½ to 2	....	15 to 20
Four-hoop fyke	15 to 50	8 to 10	4	3½	3	2½	25 to 30

A modification in the shape of the wings leads to the type of net usually designated as the "pound fyke," in which the wings are so disposed as to form a compartment answering the purposes of the "forebay" of a pound net. In some nets the wings are evenly curved, in others they are angular. Two of these nets are exhibited in plate LXXVI.

A fyke net with curved wings like those of a pound is used in Queen Anne and other counties on the eastern shore of Chesapeake Bay, and is illustrated in plate LXXVI, fig. 2. A net thus constructed is often considerably larger than the kind with straight wings used in the same region. The hoops, four or five in number, have two funnels. The entrance hoop is 4 to 9 feet in diameter. The bag or pocket is 15 to 20 feet long. The hedging is from 40 to 100 yards in length. The "forebays" are from 5 to 30 yards long. The average value of such nets is about $15, although many, constructed of old twine and set in shallow water, cost only $8 or $10. In some localities, as, for instance, the Chester River, nearly all the fykes employed are of this class.

The fyke net illustrated in plate LXXVI, fig. 1, characterized by angular wings, is the form commonly in use in the Great Lake region, where various sizes are employed. The length of the fyke proper, here called the "bowl" or "pot," varies from 10 to 20 feet; the first hoop is from 3 to 8 feet in diameter; the leader, with a mesh of 2 or 2½ inches, bar measure, is 150 to 400 feet long; the wings or hearts contain from 20 to 90 feet of netting with a 1½- or 2-inch mesh; the value is from $15 to $50. Such nets are often fished under the ice. All the fish common to the lake waters are caught. In Saginaw Bay and River, Michigan, where a large number of these nets are fished, they are known as "gobblers."

A modification of this fyke is used at Sandusky and elsewhere in the Great Lakes. The plan and elevation are shown in plate LXXVII, figs. 1 and 2. Between the bowl or pound part of the net and the fyke proper there is a section known as the tunnel, which comes to the surface at the point where it joins the bowl. The net is usually set in 12 to 15 feet of water. The barrel of the net is square, and its size is usually 4 by 15 feet. The dimensions of this style of net are given in the figure.

The largest and most elaborate of the "pound" fykes, which is represented in plate LXXVIII, is, so far as known, confined to Monmouth County, N. J., where it is used in the Raritan River, Sandy Hook Bay at Port Monmouth, and elsewhere within Sandy Hook. Briefly described, it is a modern pound net, having leader and hearts, with an ordinary five-hoop fyke taking the place of the pocket. The style shown in the figure is used at Port Monmouth, and presents the following features:

The leader is 170 feet long, and is supported by stakes driven at distances of 10 feet. The outer heart has gently curving sides, 52 feet long, with stakes at intervals of 10 feet, except at the ends, where there are two poles 6 feet apart. A supplementary piece of netting 10 feet long, on either side of the entrance of the outer heart, serves the purpose of a wing. The distance between the end of the leader and the first pole of the heart on either side is 5 feet. The outer heart projects a distance of 6 feet into the inclosure of the inner, an interval of 2 feet being left between the ends of the two sides. The inner heart is formed by the projecting ends of the outer compartment and two 10-foot pieces of netting on either side, joining each other at right angles, the inner section on each side being connected with the first hoop of the fyke by means of a special piece of netting 6 feet long, known as an apron. The first hoop is 4½ feet in diameter; the others, four in number, are 4 feet wide. An interval of 2½ feet separates the first and second and the second and third hoops, while the third and fourth and the fourth and fifth hoops are 4 feet apart. The final segment, called the tail, is about 3 feet long, and is attached by a rope to a stake by means of which the net is kept extended. A funnel extends from the first to the third hoop and is attached to the latter by means of radiating cords; a second funnel passes from the fourth to the fifth hoop.

The variations in this kind of fyke consist in an elongation or shortening of the leader and sides of the hearts, in modifications of the shape of the hearts, and in a narrowing or widening of the entrances into the latter. The value varies from $20 to $50, depending on the newness of the twine and other materials employed; the average value is about $40. This style of net is set in salt and fresh water and takes all the forms of fish occurring in the region, including shad, alewives, striped bass, squeteague, flounders, etc.

DOUBLE AND IRREGULAR FORMS OF FYKE NETS.

The nets included in this division are, for the most part, elaborated combinations and variations of the forms already described. They constitute a numerous and important class of fykes, employed chiefly in the Middle Atlantic region, where, in some places, they are the principal kinds in use. For convenience they may be considered under the head of double or symmetrical fykes and unilateral or irregular forms.

The double nets, as here regarded, consist of two simple fykes placed opposite each other, with a common leader, with or without wings, and connected on one side by a short piece of netting. The fykes are, in most types, set at right angles to the leader, but in some cases they diverge, forming an obtuse angle with the leader.

An example of a simple form of double net is shown in plate LXXIX, fig. 1; it is used in the Nanticoke River and elsewhere in Chesapeake Bay, and is there usually called a "set of fykes." It consists of two bags set facing each other, connected on one side by a curved piece of netting; from the other side a leader extends from the shore to a point opposite the entrances of the nets. The bags are 18 feet long and are separated from each other by a distance of 10 or 12 feet. There are 5 or 6 hoops and 2 or 3 funnels. The first hoop is 5 or 5½ feet in diameter, and each succeeding hoop is smaller by about 3 inches. The leader, or hedging, is 75 to 120 feet long, and consists of netting with a 3½-inch mesh.

The improvements made in this style of fyke consist in the addition of wings of various shapes and sizes, some of which are illustrated in plates LXXIX, LXXX and LXXXI. The form of net represented in plate LXXX, fig. 1, is a type of several similar styles employed in northern New Jersey, in Monmouth and Hudson counties, and used chiefly in the capture of shad. It is generally known as a shad fyke. Such nets are often set in strings containing three, four, or more nets. They are separated by leaders from 15 to 40 feet in length. The leaders are usually made wholly of twine, but in places where a long line of nets would interfere with navigation that part of the leader which joins the back of a net is often made of brush, over which vessels and boats may sail without having their course impeded and without damaging the net. A set of three nets thus placed is exhibited in plate LXXXII. These fykes have a bag 15 to 20 feet long, with 5 hoops and with 2 funnels proceeding from the first and third hoops. A similar fyke, constructed on a smaller scale, is employed in the same region for striped bass.

In Baltimore County, Md., a net of this class is in use, which is locally called a hedging fyke. The pocket is 5 to 10 feet long and has hoops from 3½ to 6 feet in diameter; as many as 9 hoops are sometimes inserted, but the usual number is less. The mouth of the bag is sometimes square. It is represented in plate LXXX, fig. 2.

One of the most noteworthy of these double forms is shown in plate LXXIX, fig. 2. It is used in Wicomico, Dorchester, Caroline, Talbot, and other counties in Maryland, and is designated a "set of fykes." It is the prevalent form in Wicomico County. Striped bass, perch, alewives, catfish, eels, pike, terrapins, and snapping turtles are caught. The fykes proper, here called pockets, are from 12 to 18 feet long, with a 2½- or 3-inch mesh. The hoops number 5 or 6; the largest is 5½ or 6 feet wide, and each succeeding hoop drops about 3 inches. There are usually two funnels, which proceed from the first and third hoops. The leader, called the hedging, is from 50 to 75 yards long and has a 3½-inch mesh. The wings are of variable length, but are usually from 20 to 50 feet; they are straight and form an angle of about 45 degrees with the leader.

A double fyke, in which the pockets are placed obliquely with reference to the leader, is employed in Hudson County, N. J., and is chiefly fished for striped bass, in the capture of which it is quite efficient. In other respects the net presents no peculiar features. A typical example has pockets 20 feet long, 5 hoops, the largest 5 feet and the smallest 4 feet in diameter, short rectangular wings, the long side of which is 10 feet long and the short side 3 feet, and a leader 75 feet in length. The average cost is $20. Plate LXXXI, fig. 1, is an illustration of this style of fyke.

Each of the double nets figured in plate LXXX, figs. 1 and 2, plate LXXXI, fig. 1, and plate LXXXII, has its prototype in unilateral nets fished in the same place, two of which are shown in plate LXXXI, fig. 2, and plate LXXXIII.

THE FYKE NET IN LAW.

From a very early date the use of the fyke net in the United States has been subject to legal restrictions. Its effectiveness was early recognized, and the possibility of much damage resulting from its unrestrained employment was appreciated in many of the coast States. Except in a few cases this net has not seemed to require special legislation—that is, it has not been liable to regulations that were not directed to other forms of apparatus, but has usually been included with seines, gill nets, pound nets, etc., in legislative enactments.

Whatever injurious results may attend the employment of the net, it is evident that these will be more pronounced the more circumscribed the body of water in which the fishing is done. Hence fyke-net fishing on the coast and in large rivers has been less subject to legal regulation than similar fishing in lakes and smaller streams or in the upper courses of rivers.

The restrictions that have been placed on the fyke have consisted for the most part of a limitation of the size of the mesh that may be used, the prohibition of its employment at certain seasons, and the determination of the waters in which it may be set.

The following enactment of the New Jersey legislature in 1870 (chapter 262), restricting the use of fykes (and weirs) on oyster beds, is perhaps the only case in which the existence of private oyster-grounds has been permitted to affect the capture of fish:

> It shall not be lawful for any person to erect stakes or any other artificial means for the purpose of using wares or fike nets (*sic*) for the taking of fish upon the bottom of North Shrewsbury River, where oysters are planted by any person or persons, without first obtaining permission in writing of the person or persons so occupying the same.

GEOGRAPHICAL REVIEW OF THE FYKE-NET FISHERIES OF THE UNITED STATES.

GENERAL IMPORTANCE AND EXTENT.

The fyke net is one of the most important means of capture employed in the fisheries of the United States. It is more or less extensively used in nearly every coast and lake State, and a very large part of the food-fish consumed in the country is caught in this form of net. In point of productiveness it is of less importance than such passive kinds of apparatus as the pound net and weir, but in proportion to the cost of construction and operation it compares favorably with these forms.

The fyke net is used in greatest numbers in the Middle Atlantic region and on the Great Lakes. It is not extensively employed in New England, except in Connecticut; it is only sparingly used in the South Atlantic States; it is entirely absent from the coastal regions of the Gulf States, and on the Pacific coast it is found only in California, where there is an unimportant fishery. The State having the largest number of fyke nets is Maryland, but the most important fishery is in New York, after which come Maryland, Ohio, Michigan, Wisconsin, and New Jersey.

The magnitude of the fyke-net fisheries of the United States is perhaps not fully appreciated, nor is their importance as a source of food supply fully understood. The following tables will therefore prove instructive; they show, for each State, the number of fyke-net fishermen, the number and value of fyke nets and boats employed, and the quantity and value of products taken. It will of course be understood that all of the fishermen shown do not depend on fyke-net fishing for a livelihood; many of them operate fyke nets in connection with other fisheries; with many fishing of any kind is only a secondary consideration, and only a few may be regarded as professional fyke-net fishermen. The same applies to the boats, which bear about the same relation to the fishery that the fishermen do. The figures relate to the years 1891 or 1892, except in the New England States, statistics for which are not available for a later year than 1889. The information contained in the tables is based on personal inquiries conducted by the field agents of the U. S. Commission of Fish and Fisheries.

The first table shows that in the year named 2,304 persons were engaged in fyke-net fishing in 16 coast and lake States; of these, 1,699 were on the Atlantic coast, 32 on the Pacific coast, and 573 on the Great Lakes.

From the second table it is seen that 25,715 fyke nets, valued at $224,300, and 1,774 boats, valued at $60,552, were employed, the total capital devoted to the industry being $284,852; of the nets, 22,698 were set on the Atlantic seaboard, 49 in the waters of the Pacific coast, and 2,968 in the Great Lakes.

The catch, as given in the third table, amounted to 12,268,975 pounds, for which the fishermen received $302,441; of this quantity, 5,827,432 pounds, valued at $176,919, were caught on the Atlantic coast, 194,647 pounds, worth $5,116, on the Pacific coast, and 6,246,896 pounds, having a value of $120,406, in the lake region.

Fishermen employed in the fyke-net fisheries of the United States.

States.	Number.	States.	Number.
Atlantic coast:		Pacific coast:	
Maine	44	California	32
Massachusetts	6		
Rhode Island	43	Great Lakes:	
Connecticut	52	New York	74
New York	577	Ohio	156
New Jersey	160	Michigan	231
Pennsylvania	60	Wisconsin	112
Delaware	27		
Maryland	595	Total	573
Virginia	98		
North Carolina	27	Grand total	2,304
Georgia	10		
Total	1,699		

Nets and boats employed in the fyke-net fisheries of the United States.

States.	Fyke nets.		Boats.		Total investment.
	No.	Value.	No.	Value.	
Atlantic Coast:					
Maine	134	$550	42	$1,810	$2,360
Massachusetts	15	100	6	200	300
Rhode Island	376	2,680	21	595	3,275
Connecticut	440	2,230	51	1,530	3,760
New York	6,246	55,465	502	16,002	71,467
New Jersey	1,562	14,191	137	4,155	18,346
Pennsylvania	2,534	5,264	59	1,604	6,868
Delaware	567	1,261	25	425	1,686
Maryland	10,398	38,114	460	7,171	45,285
Virginia	379	5,930	73	1,330	7,260
North Carolina	36	384	4	60	444
Georgia	11	285	5	70	355
Total	22,698	126,454	1,385	34,952	161,406
Pacific coast:					
California	49	980	16	1,050	2,030
Great Lakes:					
New York	684	9,822	66	2,318	12,140
Ohio	1,110	63,650	139	14,045	77,695
Michigan	446	12,030	102	2,257	14,287
Wisconsin	728	11,364	66	5,930	17,294
Total	2,968	96,866	373	24,550	121,416
Grand total	25,715	224,300	1,774	60,552	284,852

Products of the fyke-net fisheries of the United States.

States.	Pounds.	Value.	States.	Pounds.	Value.
Atlantic Coast:			Pacific coast:		
Maine	111,000	$1,380	California	194,647	$5,116
Massachusetts	44,655	1,400			
Rhode Island	114,250	3,045	Great Lakes:		
Connecticut	458,307	10,039	New York	899,527	22,561
New York	2,382,882	48,899	Ohio	2,420,650	40,373
New Jersey	591,684	25,750	Michigan	1,605,474	31,271
Pennsylvapia	146,695	6,659	Wisconsin	1,321,245	26,201
Delaware	45,091	2,591			
Maryland	1,552,432	62,115	Total	6,246,896	120,406
Virginia	335,361	13,627			
North Carolina	24,885	716	Grand total	12,268,975	302,441
Georgia	20,190	898			
Total	5,827,432	176,919			

Considering the entire country, it appears that the average number of nets in each of the States named is 1,601; the average value of the nets is about $9; the average number of nets to a man is 11; the average number of pounds of fish to a net is 477; the average stock per net is $12; the average stock per man is $131, and the average price of the products is 2½ cents per pound.

The fyke net is adapted to the capture of almost every free-swimming aquatic animal found on the coasts, in the rivers, or in the lakes of the United States. The following table exhibits the quantities and values of all the principal fishes represented in the fyke-net catch. Among the numerous economic species the most valuable are the flounders and catfishes, each of which yielded products worth over $42,000. Other specially important fishes are pike, pike perch, yellow perch, flounders, eels, striped bass, suckers, and shad. On the Atlantic coast the flatfishes are the first in importance, in the Pacific region catfish are the most valuable products, while in the Great Lakes the pike and pike perch take first rank, followed by the yellow perch. Owing to the misapplication of names on the part of the lake fishermen, satisfactory separate figures for the pike and pike perch can not be furnished.

Quantity and value of the principal products constituting the fyke-net catch of the United States.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Atlantic coast:			Pacific coast:		
Alewives	391,245	$3,144	Carp	42,115	$1,374
Bass	1,675	208	Catfish	114,575	2,870
Bluefish	29,350	1,184	Other fish	37,967	872
Butter-fish	48,850	880			
Carp	5,800	359	Total	194,647	5,116
Catfish	567,982	23,133			
Eels	351,040	17,534	Great Lakes:		
Flounders and flatfish	1,744,830	42,211	Bass	183,481	8,188
Frostfish or tomcod	77,100	1,842	Catfish	789,623	18,536
Perch, white	246,558	13,763	Eels	56,336	2,177
Perch, yellow	278,232	11,165	Herring	833,650	4,446
Pike	108,744	7,418	Perch	1,716,311	25,679
Menhaden	743,667	1,238	Pike and pike perch	1,075,085	37,161
Scup	72,065	1,759	Suckers	779,285	11,994
Shad	244,453	10,296	Trout	15,480	645
Spots and croakers	53,705	2,090	Whitefish	9,685	465
Squeteague	209,769	6,672	Other fish	1,262,255	10,601
Striped bass	183,757	15,160	Turtles	25,705	514
Suckers	138,217	6,120			
Tautog and cunners	33,665	1,549	Total	6,246,896	120,406
Other fish	167,108	5,981			
Refuse fish	97,200	243	Grand total	12,268,975	302,441
King crabs	20,000	125			
Terrapins	12,420	2,845			
Total	5,827,432	176,919			

The typical fresh-water fishes constitute much more than half the product of the fyke-net fishery; of these 8,006,013 pounds, valued at $195,898, are given in the preceding table. Of the salt-water products, 3,119,849 pounds, valued at $62,338, were obtained. Anadromous fishes yielded 1,143,113 pounds, valued at $44,205.

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An extensively used winged flounder fyke is peculiar in having elliptical hoops, four in number, with a single funnel. The long diameter of the first hoop is usually 36 inches and the short diameter 18 inches.

A fyke net of this class, used on the eastern shore of Maryland and elsewhere in Chesapeake Bay, is known by various names, and applied to the capture of various products. A common form, in use in Dorchester County, Md., and fished for terrapin, striped bass, and perch, consists of a bag 18 feet long, distended by three hoops, 6 feet apart; the first hoop being 8 feet in diameter, the second 6 feet, and the third 4 feet. Funnels proceed from the first and second hoops. The wings (locally called leaders or hedgings) are 30 to 60 feet long. A similar type, with wings 18 feet long, is known as a "sink net," on the Nanticoke River and elsewhere, and is set under the ice for striped bass and perch. Another style, with three funnels, shown in plate LXXIII, fig. 2, is called a "buckdart," in Fishing Bay, Md., and is there employed exclusively for terrapin. A fyke net with three semicircular hoops and two funnels and two short wings, known as a drop or brook fyke, is reported to have been recently used in the Delaware River, in shallow water. It had a value of $5 to $10.

FYKE NETS WITH LEADER AND WINGS.

Fykes of this class are among the most numerous, varied, elaborate, and efficient nets employed in our fisheries.

The simplest fyke of this style has an ordinary leader and two straight wings, as shown in plate LXXV, fig. 2. It is a common net in many places, and in certain parts of the Chesapeake Bay is the predominant one. The example figured, from Queen Anne County, Md., may be described as follows: The length of the net proper is 12 feet. There are five hoops, with two funnels extending from the first and third hoops; the first hoop is from 5 to 8 feet in diameter. The wings are 36 feet long, and the hedging is 40 yards long. The value of such a net is $8 to $15, depending on the newness of the materials used. Similar nets in the same region are 14 to 18 feet long, with leader from 40 to 100 yards in length. Rarely the hedging is constructed of laths nailed on crosspieces supported by uprights. These nets are adapted to the capture of striped bass, yellow perch, catfish, alewives, pike, and terrapin.

Numerous fykes of this class are employed in the Hudson River and on Long Island. They have rather short leaders (called "fences") and wings, and from two to four hoops. They are designated two-hoop, three-hoop, and four-hoop fykes. They are adapted to the capture of all kinds of river and shore fish. The approximate measurements and cost of the various kinds are as follows:

Kind of net.	Length of leader.	Length of wings.	Diameter of hoops.				Cost.
			First.	Second.	Third.	Fourth.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Dollars.*
Two-hoop fyke	10 to 15	4 to 6	2 to 3	1½ to 2	....	....	5 to 10
Three-hoop fyke	10 to 25	6 to 8	3	2 to 2½	1½ to 2	....	15 to 20
Four-hoop fyke	15 to 50	8 to 10	4	3½	3	2½	25 to 30

A modification in the shape of the wings leads to the type of net usually designated as the "pound fyke," in which the wings are so disposed as to form a compartment answering the purposes of the "forebay" of a pound net. In some nets the wings are evenly curved, in others they are angular. Two of these nets are exhibited in plate LXXVI.

Fyke nets with leaders and without wings are usually set in pairs at the ends of a common leader, the entrances to the nets facing each other. Such an arrangement has been met with in the James and York rivers, Virginia, and is considered very satisfactory in the capture of striped bass. The nets are usually placed parallel with the shore, often off the mouth of a creek or cove. The nets observed have three hoops, the first of which is 4 to 6 feet in diameter, the last 1½ feet in width; there are two funnels. The length of each bag is about 12 feet. The bag and funnels are made of netting with a 1-inch mesh. The leader is from 25 to 40 fathoms in length. A set of two nets, with the intervening leader, is worth from $30 to $50.

Two nets of this class employed in Europe are figured (plate XC, fig. 1, and plate LXXXIX, fig. 1). One, used in Portugal, consists of a simple bag, with one hoop and one funnel weighted and buoyed; the leader is relatively short and extends from an abrupt wall. The other, a Norwegian net, resembles the form already mentioned set in the United States, consisting of a net at each end of a common leader; it has 3 iron hoops of uniform size (2½ feet in diameter) and 2 funnels provided with wire apertures. Similar nets, with 5 wooden hoops of unequal sizes and 2 funnels arising from the first and third hoops, are also met with in Norway. The leader in examples inspected is about 50 feet long and is provided with cork floats and earthenware sinkers; it projects for a short distance within the cavity of the first funnel.

FYKE NETS WITH WINGS.

Fykes provided only with wings are somewhat common in certain parts of the country. This is the form usually supplied by the net companies, and, according to Mr. W. S. Shepard, of the American Net and Twine Company, Boston, Mass., is sold ready-made in a great variety of sizes, the diameter of the first hoop varying from 1 to 8 feet. The following table of descriptions and prices of nets having one and two funnels is extracted from the catalogue of the net company named; the prices include two 12-foot wings. Mr. Shepard, who has courteously furnished some interesting notes and sketches of fyke nets, remarks of those under consideration that "they are used in taking all kinds of fresh-water fish in rivers and fresh-water ponds and lakes, and are also largely used in shore fishing both on the Atlantic and Pacific coasts for fish that follow along close to the shore."

Single-throat fykes.					Double-throat fykes.				
Diameter of large hoop	Length of net.	Size of mesh.	Size of twine.	Price complete.	Diameter of large hoop.	Length of net.	Size of mesh.	Size of twine.	Price complete.
Feet.	*Feet.*	*Inches.*	*Thread.*		*Feet*	*Feet.*	*Inches.*	*Thread.*	
2½	4½	1	9	$6.00	2½	6	1	9	$7.00
3	5½	1	9	6.50	3	7	1	9	8.00
2½	4½	1½	9	4.00	2½	6	1½	9	5.00
3	5½	1½	9	4.50	3	7	1½	9	5.50
2½	4½	2	9	3.00	2½	6	2	9	4.00
3	5½	2	9	3.50	3	7	2	9	5.00
3½	6½	2	9	4.00	3½	9	2	9	5.50
4	7½	2	12	6.00	4	10½	2	12	8.00
5	9	2	15	8.00	5	13½	2	15	10.00
6	11	2	15	10.00	6	16½	2	15	12.00

A winged fyke, used in considerable numbers for taking eels, especially in Massachusetts, is illustrated in plate LXXIV, fig. 2. The barrel of the net is about 18 inches in diameter at its mouth and is set at the bottom of the junction of two diverging wings which are 6 to 8 feet deep.

The variations in this kind of fyke consist in an elongation or shortening of the leader and sides of the hearts, in modifications of the shape of the hearts, and in a narrowing or widening of the entrances into the latter. The value varies from $20 to $50, depending on the newness of the twine and other materials employed; the average value is about $40. This style of net is set in salt and fresh water and takes all the forms of fish occurring in the region, including shad, alewives, striped bass, squeteague, flounders, etc.

DOUBLE AND IRREGULAR FORMS OF FYKE NETS.

The nets included in this division are, for the most part, elaborated combinations and variations of the forms already described. They constitute a numerous and important class of fykes, employed chiefly in the Middle Atlantic region, where, in some places, they are the principal kinds in use. For convenience they may be considered under the head of double or symmetrical fykes and unilateral or irregular forms.

The double nets, as here regarded, consist of two simple fykes placed opposite each other, with a common leader, with or without wings, and connected on one side by a short piece of netting. The fykes are, in most types, set at right angles to the leader, but in some cases they diverge, forming an obtuse angle with the leader.

An example of a simple form of double net is shown in plate LXXIX, fig. 1; it is used in the Nanticoke River and elsewhere in Chesapeake Bay, and is there usually called a "set of fykes." It consists of two bags set facing each other, connected on one side by a curved piece of netting; from the other side a leader extends from the shore to a point opposite the entrances of the nets. The bags are 18 feet long and are separated from each other by a distance of 10 or 12 feet. There are 5 or 6 hoops and 2 or 3 funnels. The first hoop is 5 or 5½ feet in diameter, and each succeeding hoop is smaller by about 3 inches. The leader, or hedging, is 75 to 120 feet long, and consists of netting with a 3½-inch mesh.

The improvements made in this style of fyke consist in the addition of wings of various shapes and sizes, some of which are illustrated in plates LXXIX, LXXX and LXXXI. The form of net represented in plate LXXX, fig. 1, is a type of several similar styles employed in northern New Jersey, in Monmouth and Hudson counties, and used chiefly in the capture of shad. It is generally known as a shad fyke. Such nets are often set in strings containing three, four, or more nets. They are separated by leaders from 15 to 40 feet in length. The leaders are usually made wholly of twine, but in places where a long line of nets would interfere with navigation that part of the leader which joins the back of a net is often made of brush, over which vessels and boats may sail without having their course impeded and without damaging the net. A set of three nets thus placed is exhibited in plate LXXXII. These fykes have a bag 15 to 20 feet long, with 5 hoops and with 2 funnels proceeding from the first and third hoops. A similar fyke, constructed on a smaller scale, is employed in the same region for striped bass.

In Baltimore County, Md., a net of this class is in use, which is locally called a hedging fyke. The pocket is 5 to 10 feet long and has hoops from 3½ to 6 feet in diameter; as many as 9 hoops are sometimes inserted, but the usual number is less. The mouth of the bag is sometimes square. It is represented in plate LXXX, fig. 2.

One of the most noteworthy of these double forms is shown in plate LXXIX, fig. 2. It is used in Wicomico, Dorchester, Caroline, Talbot, and other counties in Maryland, and is designated a "set of fykes." It is the prevalent form in Wicomico County. Striped bass, perch, alewives, catfish, eels, pike, terrapins, and snapping turtles are caught. The fykes proper, here called pockets, are from 12 to 18 feet long, with a 2½- or 3-inch mesh. The hoops number 5 or 6; the largest is 5½ or 6 feet wide, and each succeeding hoop drops about 3 inches. There are usually two funnels, which proceed from the first and third hoops. The leader, called the hedging, is from 50 to 75 yards long and has a 3½-inch mesh. The wings are of variable length, but are usually from 20 to 50 feet; they are straight and form an angle of about 45 degrees with the leader.

A double fyke, in which the pockets are placed obliquely with reference to the leader, is employed in Hudson County, N. J., and is chiefly fished for striped bass, in the capture of which it is quite efficient. In other respects the net presents no peculiar features. A typical example has pockets 20 feet long, 5 hoops, the largest 5 feet and the smallest 4 feet in diameter, short rectangular wings, the long side of which is 10 feet long and the short side 3 feet, and a leader 75 feet in length. The average cost is $20. Plate LXXXI, fig. 1, is an illustration of this style of fyke.

Each of the double nets figured in plate LXXX, figs. 1 and 2, plate LXXXI, fig. 1, and plate LXXXII, has its prototype in unilateral nets fished in the same place, two of which are shown in plate LXXXI, fig. 2, and plate LXXXIII.

THE FYKE NET IN LAW.

From a very early date the use of the fyke net in the United States has been subject to legal restrictions. Its effectiveness was early recognized, and the possibility of much damage resulting from its unrestrained employment was appreciated in many of the coast States. Except in a few cases this net has not seemed to require special legislation—that is, it has not been liable to regulations that were not directed to other forms of apparatus, but has usually been included with seines, gill nets, pound nets, etc., in legislative enactments.

Whatever injurious results may attend the employment of the net, it is evident that these will be more pronounced the more circumscribed the body of water in which the fishing is done. Hence fyke-net fishing on the coast and in large rivers has been less subject to legal regulation than similar fishing in lakes and smaller streams or in the upper courses of rivers.

The restrictions that have been placed on the fyke have consisted for the most part of a limitation of the size of the mesh that may be used, the prohibition of its employment at certain seasons, and the determination of the waters in which it may be set.

The following enactment of the New Jersey legislature in 1870 (chapter 262), restricting the use of fykes (and weirs) on oyster beds, is perhaps the only case in which the existence of private oyster-grounds has been permitted to affect the capture of fish:

> It shall not be lawful for any person to erect stakes or any other artificial means for the purpose of using wares or fike nets (*sic*) for the taking of fish upon the bottom of North Shrewsbury River, where oysters are planted by any person or persons, without first obtaining permission in writing of the person or persons so occupying the same.

GEOGRAPHICAL REVIEW OF THE FYKE-NET FISHERIES OF THE UNITED STATES.

GENERAL IMPORTANCE AND EXTENT.

The fyke net is one of the most important means of capture employed in the fisheries of the United States. It is more or less extensively used in nearly every coast and lake State, and a very large part of the food-fish consumed in the country is caught in this form of net. In point of productiveness it is of less importance than such passive kinds of apparatus as the pound net and weir, but in proportion to the cost of construction and operation it compares favorably with these forms.

The fyke net is used in greatest numbers in the Middle Atlantic region and on the Great Lakes. It is not extensively employed in New England, except in Connecticut; it is only sparingly used in the South Atlantic States; it is entirely absent from the coastal regions of the Gulf States, and on the Pacific coast it is found only in California, where there is an unimportant fishery. The State having the largest number of fyke nets is Maryland, but the most important fishery is in New York, after which come Maryland, Ohio, Michigan, Wisconsin, and New Jersey.

The magnitude of the fyke-net fisheries of the United States is perhaps not fully appreciated, nor is their importance as a source of food supply fully understood. The following tables will therefore prove instructive; they show, for each State, the number of fyke-net fishermen, the number and value of fyke nets and boats employed, and the quantity and value of products taken. It will of course be understood that all of the fishermen shown do not depend on fyke-net fishing for a livelihood; many of them operate fyke nets in connection with other fisheries; with many fishing of any kind is only a secondary consideration, and only a few may be regarded as professional fyke-net fishermen. The same applies to the boats, which bear about the same relation to the fishery that the fishermen do. The figures relate to the years 1891 or 1892, except in the New England States, statistics for which are not available for a later year than 1889. The information contained in the tables is based on personal inquiries conducted by the field agents of the U. S. Commission of Fish and Fisheries.

The first table shows that in the year named 2,304 persons were engaged in fyke-net fishing in 16 coast and lake States; of these, 1,699 were on the Atlantic coast, 32 on the Pacific coast, and 573 on the Great Lakes.

From the second table it is seen that 25,715 fyke nets, valued at $224,300, and 1,774 boats, valued at $60,552, were employed, the total capital devoted to the industry being $284,852; of the nets, 22,698 were set on the Atlantic seaboard, 49 in the waters of the Pacific coast, and 2,968 in the Great Lakes.

The catch, as given in the third table, amounted to 12,268,975 pounds, for which the fishermen received $302,441; of this quantity, 5,827,432 pounds, valued at $176,919, were caught on the Atlantic coast, 194,647 pounds, worth $5,116, on the Pacific coast, and 6,246,896 pounds, having a value of $120,406, in the lake region.

One of the most noteworthy of these double forms is shown in plate LXXIX, fig. 2. It is used in Wicomico, Dorchester, Caroline, Talbot, and other counties in Maryland, and is designated a "set of fykes." It is the prevalent form in Wicomico County. Striped bass, perch, alewives, catfish, eels, pike, terrapins, and snapping turtles are caught. The fykes proper, here called pockets, are from 12 to 18 feet long, with a 2½- or 3-inch mesh. The hoops number 5 or 6; the largest is 5½ or 6 feet wide, and each succeeding hoop drops about 3 inches. There are usually two funnels, which proceed from the first and third hoops. The leader, called the hedging, is from 50 to 75 yards long and has a 3½-inch mesh. The wings are of variable length, but are usually from 20 to 50 feet; they are straight and form an angle of about 45 degrees with the leader.

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Fishermen employed in the fyke-net fisheries of the United States.

States.	Number.	States.	Number.
Atlantic coast:		Pacific coast:	
Maine	44	California	32
Massachusetts	6	Great Lakes:	
Rhode Island	43	New York	74
Connecticut	52	Ohio	156
New York	577	Michigan	231
New Jersey	160	Wisconsin	112
Pennsylvania	60	Total	573
Delaware	27	Grand total	2,304
Maryland	595		
Virginia	98		
North Carolina	27		
Georgia	10		
Total	1,699		

Nets and boats employed in the fyke-net fisheries of the United States.

States.	Fyke nets.		Boats.		Total investment.
	No.	Value.	No.	Value.	
Atlantic Coast:					
Maine	134	$550	42	$1,810	$2,360
Massachusetts	15	100	6	200	300
Rhode Island	376	2,680	21	595	3,275
Connecticut	440	2,230	51	1,530	3,760
New York	6,246	55,465	502	16,002	71,467
New Jersey	1,562	14,191	137	4,155	18,346
Pennsylvania	2,534	5,264	59	1,604	6,868
Delaware	567	1,261	25	425	1,686
Maryland	10,398	38,114	460	7,171	45,285
Virginia	379	5,930	73	1,330	7,260
North Carolina	36	384	4	60	444
Georgia	11	285	5	70	355
Total	22,698	126,454	1,385	34,952	161,406
Pacific coast:					
California	49	980	16	1,050	2,030
Great Lakes:					
New York	684	9,822	66	2,318	12,140
Ohio	1,110	63,650	139	14,045	77,695
Michigan	446	12,030	102	2,257	14,287
Wisconsin	728	11,364	66	5,930	17,294
Total	2,968	96,866	373	24,550	121,416
Grand total	25,715	224,300	1,774	60,552	284,852

Products of the fyke-net fisheries of the United States.

States.	Pounds.	Value.	States.	Pounds.	Value.
Atlantic Coast:			Pacific coast:		
Maine	111,000	$1,380	California	194,647	$5,116
Massachusetts	44,655	1,400	Great Lakes:		
Rhode Island	114,250	3,045	New York	899,527	22,561
Connecticut	458,307	10,039	Ohio	2,420,650	40,373
New York	2,382,882	48,899	Michigan	1,605,474	31,271
New Jersey	591,684	25,750	Wisconsin	1,321,245	26,201
Pennsylvania	146,695	6,659	Total	6,246,896	120,406
Delaware	45,091	2,591	Grand total	12,268,975	302,441
Maryland	1,552,432	62,115			
Virginia	335,361	13,627			
North Carolina	24,885	716			
Georgia	20,190	898			
Total	5,827,432	176,919			

Considering the entire country, it appears that the average number of nets in each of the States named is 1,601; the average value of the nets is about $9; the average number of nets to a man is 11; the average number of pounds of fish to a net is 477; the average stock per net is $12; the average stock per man is $131, and the average price of the products is 2½ cents per pound.

The fyke net is adapted to the capture of almost every free-swimming aquatic animal found on the coasts, in the rivers, or in the lakes of the United States. The following table exhibits the quantities and values of all the principal fishes represented in the fyke-net catch. Among the numerous economic species the most valuable are the flounders and catfishes, each of which yielded products worth over $42,000. Other specially important fishes are pike, pike perch, yellow perch, flounders, eels, striped bass, suckers, and shad. On the Atlantic coast the flatfishes are the first in importance, in the Pacific region catfish are the most valuable products, while in the Great Lakes the pike and pike perch take first rank, followed by the yellow perch. Owing to the misapplication of names on the part of the lake fishermen, satisfactory separate figures for the pike and pike perch can not be furnished.

Quantity and value of the principal products constituting the fyke-net catch of the United States.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Atlantic coast:			Pacific coast:		
Alewives	391,245	$3,144	Carp	42,115	$1,374
Bass	1,675	208	Catfish	114,575	2,870
Bluefish	29,350	1,184	Other fish	37,957	872
Butter-fish	48,850	880			
Carp	5,800	859	Total	194,647	5,116
Catfish	567,982	23,133			
Eels	351,040	17,534	Great Lakes:		
Flounders and flatfish	1,744,830	42,211	Bass	183,481	8,188
Frostfish or tomcod	77,100	1,842	Catfish	789,623	18,536
Perch, white	246,558	13,763	Eels	56,336	2,177
Perch, yellow	278,232	11,165	Herring	333,650	4,446
Pike	108,744	7,418	Perch	1,716,311	25,679
Menhaden	743,667	1,238	Pike and pike perch	1,075,085	37,161
Scup	72,065	1,759	Suckers	779,285	11,994
Shad	244,453	10,296	Trout	15,480	645
Spots and croakers	53,705	2,090	Whitefish	9,685	465
Squeteague	209,769	6,672	Other fish	1,262,255	10,601
Striped bass	183,757	15,160	Turtles	25,705	514
Suckers	138,217	6,120			
Tautog and cunners	33,665	1,549	Total	6,246,896	120,406
Other fish	167,108	5,981			
Refuse fish	97,200	243	Grand total	12,268,975	302,441
King crabs	20,000	125			
Terrapins	12,420	2,845			
Total	5,827,432	176,919			

The typical fresh-water fishes constitute much more than half the product of the fyke-net fishery; of these 8,006,013 pounds, valued at $195,898, are given in the preceding table. Of the salt-water products, 3,119,849 pounds, valued at $62,338, were obtained. Anadromous fishes yielded 1,143,113 pounds, valued at $44,205.

The following table is a classification of the products of this industry, based on the nature of the water in which caught. The table is not entirely satisfactory, however, owing to the fact that the catfish and eels, which are classed as fresh-water fishes, are in small part taken in salt and brackish water, but can not be separately shown.

Classification of the products of the fyke-net fisheries.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Salt-water products:			Fresh-water products:		
Bluefish	29,350	$1,184	Bass	112,803	$6,551
Butter-fish	48,850	880	Carp	47,915	1,733
Flounders and flatfish	1,744,830	42,211	Catfish	1,472,180	44,539
Menhaden	743,667	1,238	Eels	407,376	19,711
Scup	72,065	1,759	Herring (lake)	333,650	4,446
Spots and croakers	53,705	2,090	Perch, yellow	1,994,543	36,844
Squeteague	209,769	6,672	Pike and pike perch	1,183,829	44,579
Tautog and cunners	83,665	1,549	Suckers	917,502	18,114
Other fish	54,328	1,542	Trout (lake)	15,480	645
Refuse fish	97,200	243	Whitefish	9,685	465
King crabs	20,000	125	Other fish	1,485,345	17,757
Terrapins	12,420	2,845	Turtles	25,705	514
Total	3,119,849	62,338	Total	8,006,013	195,898
Anadromous fish:			Grand total	12,268,975	302,441
Alewives	391,245	3,144			
Frostfish or tomcod	77,100	1,842			
Perch, white	246,558	13,763			
Shad	244,453	10,296			
Striped bass	183,757	15,160			
Total	1,143,113	44,205			

FISHING SEASON, METHODS, MARKETS, ETC.

The fishing season for fyke nets varies somewhat with the locality and with the fish taken, but in most places it continues throughout the spring, summer, and fall months. In the Great Lakes, Maine, Rhode Island, Chesapeake Bay, and elsewhere, considerable fishing is also done under the ice.

Fyke nets are usually tended in boats, but in a few localities the physical features are such that the fishermen can wade out to their nets and lift them. In some places the nets are lifted daily, in others only two or three times a week, the frequency depending on the abundance of fish, the state of the weather, the condition of the market, and, to a certain extent, on the kinds of fish taken. Most fykes are so constructed as to provide for the removal of the fish from the final compartment, the end of which is closed by means of a purse string. The end of the net, being detached from the stake or anchor which holds it in position, is drawn into the boat and the contents are taken out without the necessity of loosening the entire net. Small nets, however, like the drop fykes in the Middle Atlantic States, are drawn bodily into the boat. When fykes are set under the ice, the pocket is reached and the fish are extracted through a hole in the ice, the body of the net remaining undisturbed, as in ordinary fishing.

Nothing of special application can be said regarding the methods of handling the fish caught in fyke nets, the lines of distribution, the markets, etc. These vary with the locality and do not differ from the cases of other fisheries in the same regions. Fykes are often employed in conjunction with other apparatus, the catch in the different nets being shipped together.

THE NEW ENGLAND STATES.

The fyke-net fishery of the New England States is not of great importance and is completely overshadowed by many other fisheries. Nets are found in all the States except New Hampshire, are most numerous in Connecticut, and least so in Massachusetts, and the fishery increases in value from north to south. The nets are inexpensive, having an average value of less than $6; they are cheapest in Maine and have the highest value in Rhode Island. Only a few kinds of fish are caught, and only flounders are taken in any considerable quantities and in every State; the other fish obtained are frostfish, butter-fish, tautog, cunners, menhaden, scup, striped bass, and smelt.

The following condensed table shows the condition of the fyke-net fisheries of the New England States. More detailed figures for the products will appear in the discussion for each State.

Summary of the fyke-net fishery of the New England States.

States.	No. of fishermen.	Fyke nets.		Boats.		Products.	
		No.	Value.	No.	Value.	Pounds.	Value.
Maine	44	134	$550	42	$1,810	111,000	$1,380
Massachusetts	6	15	100	6	200	44,655	1,400
Rhode Island	43	376	2,680	21	595	114,250	3,045
Connecticut	52	440	2,230	51	1,530	455,250	8,759
Total	145	965	5,560	120	4,135	725,155	14,584

MAINE.

The fyke net is not very popular in this State, and the fishery with this apparatus is almost lost sight of in comparison with other very extensive river fisheries. It is probable that fyke nets in addition to those shown in the tables are used in the interior or more remote coastal sections; inquiries carried on by the Fish Commission, however, covered all fyke-net fishing of importance in the coast rivers.

The employment of fyke nets as an economic pursuit is to be noted in only three coastal counties, namely Lincoln, Sagadahoc, and Cumberland, the last-named having the most important interests; of the 134 nets used in 1889, 101 were credited to this county, although fewer men and boats are employed than in Lincoln County, owing to differences in methods. Three species comprise all the marketable fish taken; these are flounders, frostfish or tomcod, and smelt. The flounders are by far the most important, as shown in the following table. The aggregate catch in Cumberland County is much larger than in the two other counties combined, amounting to 82,000 pounds, valued at $1,050 and comprising practically only flounders, while in Lincoln County the yield was 25,000 pounds of flounders, valued at $230, and in Sagadahoc the output consisted of 4,000 pounds of frostfish and smelt, with a value of $100.

Products of the fyke-net fishery of Maine.

Species.	Pounds.	Value.
Flounders	107,000	$1,280
Frostfish	2,500	10
Smelt	1,500	90
Total	111,000	1,380

Mr. C. G. Atkins, of the U. S. Fish Commission, in a report* on the river fisheries of Maine, speaks of the fyke nets used in the smelt fishery as "double bag nets, the large open-mouthed net in front leading by a narrow opening at its apex into a smaller one, termed the 'pocket,' from which, as from a weir, fish escape with difficulty. The fish are taken out by drawing up the 'pocket,' through a separate hole in the ice, and unlacing an opening at the bottom, the main part of the fyke remaining under water for weeks or months." Mr. Atkins further says that "the fyke has been used in various parts of the State, but does not appear to have given entire satisfaction. There is complaint of its being more difficult to clean of rubbish, anchor ice, etc., than the plain bag net, which has in some cases superseded it."

In the Wescongus or Pleasant River it was reported in 1880 that most of the smelt nets were fykes. "They are set by attaching them to poles, which are planted through the ice into mud in a location where the water is 8 feet deep at low tide. The nets are set both on the flood and ebb tide, and hauled at both high and low water. Fishing begins as soon as the ice will bear, which is generally about December 10 or 15, and continues till near April 1, the limit fixed by law."

In the Kennebec River, the introduction of small fykes was accomplished in 1851. They were used in the river for many years, but the fykes have gradually been supplanted by the bag nets, introduced at the same time.

MASSACHUSETTS.

Fyke nets are used for commercial fishing in Essex, Barnstable, and Bristol counties, in this State. They are most numerous and important in the last-named county, but, considering the entire State, are among the least productive of the forms of fishing apparatus there used. Only six persons were engaged in tending these nets in the last year covered by the inquiries of the Fish Commission, only fifteen typical nets were employed, and the product was less than 45,000 pounds. The fishes entering into the catch are chiefly scup, flounders, butter-fish, and cunners, of which the scup are the most important. The catch consisted of 44,655 pounds, valued at $1,400, of which 39,165 pounds, worth $1,098, were taken in Bristol County. The quantities of each species were as follows:

Products of the fyke-net fishery of Massachusetts.

Species.	Pounds.	Value.
Butter-fish	2,650	$82
Cunners	2,340	210
Flounders	10,200	264
Scup	29,465	844
Total	44,655	1,400

It may be stated that there are also used in parts of Massachusetts numbers of pot-like nets, as represented in plate LXXIV, fig. 1, which have been regarded as forms of fykes by the writer but were classed as pots in the canvass of the fisheries by the agents of the Fish Commission.

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*The Fisheries and Fishery Industries of the United States, section V, vol. I. History and Methods, p. 692.

RHODE ISLAND.

Considering the length of its coast line, Rhode Island has a rather extensive fyke-net fishery compared with the other States of this region. Nets are set in three coast counties, between 100 and 200 nets being operated in each county. The nets employed in Rhode Island present the same general features of construction and shape as those in New York, although some types peculiar to the State are used. The fykes are most valuable in Washington County, most numerous and productive in Kent County, and relatively the most important in Newport County. The 43 fisherman have on an average 9 nets each, with a boat to each 18 nets and each 2 men. The average catch to a net is about 305 pounds, worth $8. The fishery at the present time is essentially a flounder fishery, flounders being the only commercial fish taken. Of the 114,250 pounds secured, about 50,000 pounds, valued at $1,200, were caught in Kent County; 35,000 pounds, worth $1,050, in Newport County, and 29,250 pounds, valued at $795, in Washington County. Most of the fishing is done in winter under the ice.

Compared with 1880, the fyke-net fishery of Rhode Island has undergone a noticeable decline as well a marked change in methods and in the fish taken. In that year, 865 nets, valued at $7,530, were set in the waters of the State. Of Little Narragansett Bay and Pawcatuck River it was stated:

> There are fully fifty fyke nets employed. They are set thus: At the center of one side of the heart of a pound net a hoop fyke is attached, opening into the heart; when the net is lifted, instead of "bunting" the net toward the further end of the bowl and then bailing the fish out, as is usually done, they are driven into one of the hearts, and thence into the fyke; the end of this is lifted into a boat into which the fish are emptied. The mesh in these fykes is very fine. Fyke-nets are also set all along the shore in shallow water, and catch chiefly bass, flounders, and perch.*

The most numerous and generally distributed fyke net now employed in the State has two diverging wings and a leader, as represented in plate LXXV, fig. 2. The wings are 18 to 20 feet long, and the leader is 50 to 100 feet long, depending on the nature of the locality in which the net is set. About 5 stakes are usually required to support the leader, which is 3 to 4 feet deep. The wings are kept in position by a single stake at their outer ends, the inner end being attached to the first hoop. The bag is about 15 feet long or less and is distended by 3 or 4 hoops, the first being 3½ to 4 feet in diameter, each succeeding hoop decreasing in size by 6 or 8 inches. Some nets have 1 funnel and some 2 funnels. The net is kept in place by a painter or stayline attached to the end of the pocket and made fast by a half hitch to a stake driven in the bottom. The cost of such a net is $6 to $10. The manner of rigging the nets is often varied somewhat by different fishermen. In Little Narragansett Bay, for instance, a fyke has recently been used with a square entrance and a prism-shaped funnel leading into the cavity of the net. This feature the fishermen think is an advantage over the ordinary circular entrance in the case of large fykes set in comparatively deep water.

The nets are usually set in shoal water. In some localities tautog, in addition to flatfish, are now caught. The fishing season is fall and winter. Fishing under the ice is considered more profitable than in the open water and is the customary method pursued, owing to the fact that the products then command a much higher price than during the season of open water.

A peculiar form of apparatus used at Apponaug during the past three years for taking flatfish resembles in some respects both the fyke net and the pot, but seems more nearly related to the former and is regarded by fishermen as a type of fyke. The apparatus consists of ten or more individual traps set in one line and connected by leaders. Each trap is composed of two bowed pieces of wood, forming the ends, over which the netting is placed. It is flat on the bottom, and is 3 feet long, 18 inches deep, and 2 feet wide at the base. A funnel is placed in one end of the trap. Two such nets are set facing each other at the ends of a leader 15 feet in length, and four or more with their entrances in the same direction as the first net are added to each end, with short leaders intervening. The entire string is kept in position by being anchored at the two ends with stone weights. Such nets are usually set in shallow water, but a buoy is used to mark their position. They are reputed to be very effective in the capture of flatfish. A series of ten nets when new is worth $15.

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* Fisheries and Fishery Industries of the United States, section II, p. 310.

The principal reason assigned for the decrease in the number of fykes used in this State in recent years is the scarcity of the fish sought. As the fishery entails considerable exposure to cold and inclement weather, there is little inducement to continue the business if fish are not reasonably abundant. The scarcity of ice for a number of years prior to 1892–93 was also unfavorable to the development of this fishery. The increase in pound nets, which has been marked, has also tended to diminish fishing with related forms of apparatus.

CONNECTICUT.

As already shown, the fyke-net fishery of Connecticut is more important than that of any other New England State. Compared with 1880, the fishery seems to have about doubled in extent, judging by the number of nets used, although there are no data for 1880 on which to base a comparison of the catch and stock. The average value of the nets, however, seems to have decreased. In 1880, the number of fykes reported for the State was 255, valued at $2,480; in 1889 the number was 440, worth $2,230.

Fyke-net fishing is carried on along most parts of the coast of this State. All the prominent towns have more or less fishing of this kind. The largest number of nets is found in Stonington, Quiambog, Mystic, Noank, and New London. The distribution of the fykes in 1889 was as follows:

Towns.	No. of nets.	Towns.	No. of nets.
Stonington	64	Branford	7
Quiambog	110	Milford	10
Mystic	32	Stratford	20
Noank	68	Southport	1
Poquonoc	21	Norwalk	5
New London	54	Darien	7
Niantic	15	Stamford	5
Saybrook	21		

The fish now taken in the fyke nets of Connecticut are principally flounders, frostfish, tautog, menhaden, and striped bass. In a few places terrapin are taken, and in Stratford these are much more valuable than the remaining part of the catch. In 1880 the species reported to be caught in fyke nets were sea bass, cod, bluefish, eels, weakfish, flounders, herring, shad, and occasionally sturgeon. At Mystic the nets are set about February 1 and taken up about March 31; they are again set about October 1 and remain down until December 31. Flatfish and frostfish are taken. At Noank, the nets are fished from the first of February to the last of April, and from the first of October to the middle of December. The principal fishing, however, is done in the spring. The nets are placed in water 6 to 15 feet deep. In Groton the fykes are operated at the mouths of the rivers during June and July, and within the rivers during the rest of the year; flounders and frostfish are secured. The largest catch is made in Quiambog, where the greatest number of nets is used. Here nearly 140,000 pounds of flounders, frostfish, and tautog, valued at $2,550, were obtained in 1889. Seven nets at Branford were fished for menhaden; about 100,000 fish were taken in the year named.

The fyke-net fishery of Connecticut in 1889 resulted in the capture of 455,250 pounds of fish, valued at $8,759, and 1,019 terrapin, worth $1,280. The quantities of the different fishes were as follows:

Products of the fyke-net fishery of Connecticut.

Species.	Pounds.	Value.
Flounders	347,400	$6,899
Frostfish	26,000	660
Menhaden	66,500	375
Striped bass	7,350	475
Tautog	8,000	350
Total	455,250	8,759

THE MIDDLE ATLANTIC STATES.

The Middle Atlantic region, as here considered, includes the States of New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. From every point of view this is the most important fyke-net section of the country. More persons are here employed in fishing fykes, more nets are set, more products are taken, and more money accrues to the fishermen than in any other region.

The statistics of this fishery in 1891, specified by States, are exhibited in the following table. It appears that 1,517 persons were engaged in tending fykes, that 21,686 nets, valued at $120,225, were used, and that 5,056,145 pounds of fish and other products, valued at $159,341, were taken. The fishermen and nets are most numerous and the value of the fishery is greatest in Maryland; the amount invested in fykes and boats, the number of boats, and the quantity of fish taken are greatest in New York. Pennsylvania and Delaware have the least important fisheries.

Fyke-net fishing of the Middle Atlantic States.

States.	Number of fishermen.	Fyke nets.		Boats.		Products.	
		Number.	Value.	Number.	Value.	Pounds.	Value.
New York	577	6,246	$55,465	502	$16,002	2,382,882	$48,899
New Jersey	160	1,562	14,191	137	4,156	593,684	25,450
Pennsylvania	60	2,534	5,264	59	1,604	146,695	6,659
Delaware	27	567	1,261	25	425	45,091	2,591
Maryland	595	10,398	38,114	460	7,171	1,552,432	62,115
Virginia	98	379	5,930	73	1,330	335,361	13,627
Total	1,517	21,686	120,225	1,256	30,687	5,056,145	159,341

NEW YORK.

In the value of its fyke-net fishery, New York ranks before any other State, surpassing Maryland, the next important State, by about ten thousand dollars' worth of products. In the waters of the State tributary to the Atlantic Ocean, however, the extent of the fishery is less than in Maryland.

The physical features of this State naturally fall for discussion under three general heads: Long Island, Staten Island, and the Hudson River. Consideration of the fyke-net fishery in the Great Lakes on which the State has a frontage will be taken up in the chapter on the lake region. The extent of this fishery in each of these regions in 1891 was as follows:

Sections.	Fishermen.	No. of nets.	Value of catch.
Staten Island	18	215	$1,450
Long Island*	483	4,883	42,459
Hudson River	76	1,148	4,990
Total	577	6,246	48,899

* Including part of Westchester County bordering on Long Island Sound.

The principal fishes taken in the Long Island region are flounders and flatfishes, so called; these constitute two-thirds of the value of the catch and are particularly important in Suffolk County. Other fish which have some prominence are squeteague, bluefish, shad, butter-fish, tomcod, and menhaden. This is one of the sections in which terrapins have been taken in fykes, although the present scarcity of these animals, as compared with earlier times, reduces the importance of the fishery to a minimum, and in the last year for which statistics are available it would seem that no terrapin were caught in this way. In 1889, however, in parts of Queens County small numbers were taken. At Bayville these were caught by means of fykes set across a stream, and resting on the bottom. The season began about July 20 and closed September 1. The fykes were set well up the stream and only remained about forty-eight hours, when they were changed to another stream. There were only about one-half as many terrapin caught as there were ten years ago. In 1872, in one night, four fykes caught 212 terrapin. After they were caught, the practice was to keep them in a pen until prospects were favorable for a good market. When in confinement they were fed on "fiddlers" up to within 10 days of the time of marketing them, when they were given corn meal. One man with the aid of a boy could make $8 per day at this fishery. These terrapin brought from 15 cents to $1.25 apiece, averaging about 80 cents.

On the northern shore of Long Island Sound, in Westchester County, from thirty to fifty fykes have been set annually during recent years. They have an average value of $25, and catch mostly tomcod, flounders, striped bass, and tautog or blackfish. A fyke (plate LXXV, fig.1) used at New Rochelle and elsewhere along this shore consists of the ordinary 5-hooped bag, with two funnels and two asymmetrical wings. One of the wings, made of seven pieces of netting each 9 feet long, extends from the shore in the form of a bow and joins the side of the first hoop; the other consists of three short sections, 12, 5, and 4 feet long, respectively, the longest arm extending from the net toward the shore and joining the middle piece, which runs parallel with the shore and makes an acute angle with the free end, which projects toward the mouth of the net, the whole forming a pocket from which the fish are led into the net.

A few interesting early references to fyke-net fishing on the shores of Staten Island have been met with. In a paper on "Agriculture in Richmond County," contained in the New York State Agricultural Report for 1842, the following statement occurs under the head of "spring and fall fike fishing":

> There are also other inhabitants of the ocean frequenting the southern shores of the island which divert attention from farming. In the cool weather of spring and autumn small fikes are set, extending but a short distance into the water, for taking the smaller kinds of fish which run with the tides close along shore, and furnish a domestic supply. Among them, however, are sometimes fish of a larger size, and such as are taken with the hook and line in deeper waters. In these fikes are taken: Blackfish (*Labrus tautoga*), striped bass (*Perca mitchilli*), weakfish (*Labrus squeteague*), kingfish (*Sciæna nebulosa*), tomcod or frostfish (*Gadus tomoodus*), flounder (*Pleuronectes planus*), the scientific names being from Mitchill's New York Fishes.

The same paper has this additional reference to fyke nets:

> On Staten Island the seine or draw net is sometimes employed in taking shad, but the fike or stationary hoop net is principally used to capture them. Along the southern and eastern shore of the island, every person who has a farm fronting on the water where the shad run, has his fike or fikes prepared in due season, and set at a proper distance from the shore. The fike is lifted at every low tide and the fish taken out. If the proprietor takes more than is required for his own consumption, the surplus is sent to the New York market. Occasionally, in some situations, the fishery is more productive than the farm. But in the memory of the writer the run of shad has very much diminished.

At the present time the principal species taken in this region are alewives, catfish, eels, white perch, shad, and striped bass, the most valuable being catfish, eels, and shad.

In ten counties on the Hudson River fyke nets are employed in greater or less quantities. They are most numerous and important in Albany, Rensselaer, Orange, and Rockland counties. They are mostly simple two-hoop, three-hoop, and four-hoop nets, with short wings and leader, such as are referred to on page 307. In the lower part of the river they are set in water 40 to 50 feet deep, but in the upper course of the stream they are mostly placed in 10 to 20 feet of water. The chief fishes taken are catfish, perch, striped bass, and suckers.

From the following tables the extent of the fyke-net fishery in each county can be seen. After Suffolk County, which has the most important fishery, the principal counties are Kings, Queens, and Westchester, in each of which the value of the products is more than $2,000.

Fishermen.

Counties.	Number.
Albany	5
Columbia	10
Dutchess	5
Greene	4
Kings	23
Orange	7
Putnam	2
Queens	25
Rensselaer	8
Richmond	18
Rockland	17
Suffolk	424
Ulster	5
Westchester	24
Total	577

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Albany	295	$1,565	5	$460
Columbia	71	495	10	185
Dutchess	136	840	6	115
Greene	52	290	4	65
Kings	205	1,860	26	720
Orange	156	933	8	155
Putnam	17	102	2	40
Queens	213	2,340	26	1,235
Rensselaer	161	885	5	95
Richmond	215	2,150	25	500
Rockland	125	1,525	30	1,150
Suffolk	4,430	40,515	324	9,882
Ulster	72	400	5	80
Westchester	98	1,565	26	1,320
Total	6,246	55,465	502	16,002

Products.

Species.	Albany.		Columbia.		Dutchess.		Greene.		Kings.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish	6,530	$327	6,280	$299	3,600	$180	2,750	$138	9,300	$360
Eels									10,857	570
Flounders and flatfish									10,240	280
Perch, white	1,550	124	2,850	232	1,375	110	1,125	90	2,950	110
Shad									23,360	1,460
Squeteague									4,970	240
Striped bass	125	15	255	31	65	8	75	9	4,000	520
Suckers	3,360	168	1,618	89	1,800	100	780	38		
Other fish	160	8	320	16	85	5	100	6	5,818	160
Total	11,725	642	11,323	667	6,925	403	4,830	281	71,495	3,700

Species.	Orange.		Putnam.		Queens.		Rensselaer.		Richmond.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives									6,400	$80
Catfish	4,820	$241	2,050	$102	7,835	$260	6,000	$289	5,980	235
Eels					9,143	480			5,330	280
Flounders and flatfish					57,240	1,431				
Perch, white	1,775	142	525	42			1,750	140	1,980	80
Shad									7,080	495
Striped bass	95	13	75	9	520	64	85	10	1,525	183
Suckers	1,350	76	500	28			2.475	142		
Other fish	150	8	85	5	5,086	150	75	4	3,235	97
Total	8,190	480	3,235	186	79,824	2,385	10,385	585	31,580	1,450

Species.	Rockland.		Suffolk.		Ulster.		Westchester.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			25,920	$324					32,320	$404
Bluefish			28,350	1,134					28,350	1,134
Butter-fish			43,200	648					43,200	648
Catfish	3,600	$180	12,150	243	4,600	$221	2,450	$123	77,945	3,198
Eels			6,090	320					31,420	1,650
Flounders and flatfish			986,700	24,277			10,000	500	1,064,180	26,488
Kingfish			265	40					265	40
Menhaden			648,000	810					648,000	810
Perch, white	1,775	142			1,850	148	1,050	84	20,555	1,444
Scup			40,500	810					40,500	810
Sea bass			8,100	405					8,100	405
Shad	1,550	78					800	40	32,790	2,073
Squeteague			108,000	3,240					112,970	3,480
Striped bass	1,650	196	1,650	200	85	10	6,100	732	16,305	2,000
Sturgeon	1,050	42					650	26	1.700	68
Suckers	1,875	110			1,050	68	1,900	76	16,708	895
Tautog			10,125	405			8,000	400	18,125	805
Tomcod			40,600	772			8,000	400	48,600	1,172
Other fish	750	45	27,360	608	150	9	275	16	43,649	1,132
Refuse fish			97,200	243					97,200	243
Total	12,250	793	2,084,210	34,474	7,735	456	39,225	2,397	2,382,882	48,899

NEW JERSEY.

This State holds the third place in this region as regards the extent of its fyke-net fishery. It has a large variety of localities adapted to the use of this apparatus; two important rivers, the Hudson and Delaware, as well as many smaller streams, afford an abundance of anadromous and fresh-water fish, and the numerous large and small bays on the coast yield salt-water and also anadromous species in great quantities. In few other States is a greater variety of fyke nets found nor are more expensive forms in use. The most elaborate style that has been met with, shown in plate LXXVIII, is here employed.

The largest numbers of nets are used in the Delaware River, but the most expensive and efficient forms are fished in that part of the State within Sandy Hook; only a few nets are operated on the outer shore, although some of these are of large size and catch considerable quantities of fish.

In Hudson County and some other parts of northern New Jersey, the principal fish taken in fyke nets is the shad, in the capture of which special types of nets are employed known as shad fykes; these have already been described and are figured in plates LXXX, fig. 1, LXXXII, and LXXXIII. The shad fykes are set doubly or singly, according to the locality, conditions of the shore and bottom, and the whim of the fishermen. When set singly, shad fykes in Hudson County are always so placed that the mouth of the net faces the outgoing tide; a net so set is called a "flood fyke." When placed double, one net faces the incoming tide and is termed an "ebb fyke." The fishing season is usually from April 1 to May 20, during which time small quantities of white perch, alewives, and eels, in addition to shad, are caught. In late years, a few salmon (*Salmo salar*) have also been taken. The nets are tended in sail and row boats, and about ten nets are set by each man. These fykes, complete with leaders, cost $15 to $20 each.

The shad fykes in that part of Hudson County between Jersey City and Bergen Point took the following quantities of shad in each of the years named:

Years.	Pounds.	Value.
1889	184,000	$5,520
1890	166,000	6,225
1891	124,000	4,960
1892	130,000	5,850

Evolution of the fyke net in Monmouth County.—Prior to the spring of 1870 all of the fyke nets employed in the vicinity of Port Monmouth were similar in construction to the style indicated in plate LXXV, fig. 2, that is, they were provided with a leader and two wings. In the year mentioned improvements were inaugurated by two parties of fishermen. One company advocated and adopted a form of double fyke net (plate LXXX, fig. 1), with a common leader, a wing to each net, and a back piece of netting extending between the first hoops, and was opposed to the more elaborate type (plate LXXVIII), introduced and operated by Mr. Martin C. Lohsen, consisting of a leader, wings, and two hearts, like a modern pound net. A fair trial showed that the latter form was so much more successful that it gradually displaced the others and is now the only kind used at Port Monmouth. While the simpler fyke nets took only or principally flounders, the improved style catches shad, striped bass, weakfish, eels, and other fish in large quantities. This type of fyke net, designated a "pound fyke," has been described. It is set singly, in pairs, or in strings containing from three to six nets, and has a value of $30. The "pound fyke" is used at various other places in northern New Jersey. It is always essentially similar to the Port Monmouth type, the variations in construction being of minor importance.

The restrictions which in recent years have been placed on fyke nets in the Delaware River have considerably reduced the visible or apparent extent of the fishery and made difficult the study of the subject. Practically all of the fishing is done at night, at the risk of fine, imprisonment, and the confiscation of apparatus. The darker the night and the more stormy the weather the better it suits the fishermen.

The principal forms of fykes used in the Delaware are the "drop fykes" or "brook fykes," sometimes locally called "pike nets." These are usually set in shallow water. Sometimes twenty to twenty-five nets are fastened together, the small end of one net being attached by a line to the bottom of the first hoop of the next net. A line with a buoy is fastened to the small end of the first net. Sometimes the buoy line is carried to the shore and tied to a twig in an inconspicuous place in order to avoid the watchful eye of the fish warden, who often sails directly over a long string of nets without knowing of their presence. In some instances the strings of nets are set without buoy lines or shore lines; "marks" or "ranges" are then taken by one man on shore while the other is setting the nets. A long pole or boathook is then required to haul up the nets. When set singly, as the brook fykes often are, they are placed as shown in plates LXXII and LXXIII, fig. 1, that is, they are kept in position by means of stones.

The extent of this fishery in 1891 was as follows, the figures being shown by counties:

Fishermen.

Counties.	No.
Atlantic	1
Burlington	58
Cape May	2
Hudson	21
Middlesex	4
Monmouth	53
Ocean	21
Total	160

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Atlantic	12	$56	1	$25
Burlington	1,055	3,755	49	980
Cape May	3	150	1	50
Hudson	210	3,750	16	1,450
Middlesex	22	990	2	225
Monmouth	213	4,430	52	1,131
Ocean	47	1,060	16	294
Total	1,562	14,191	137	4,155

Products.

Species.	Atlantic.		Burlington.		Cape May.		Hudson.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives			96, 550	$483			800	$12
Black bass			1, 000	140				
Carp			2, 000	160				
Catfish			21, 340	1, 707				
Eels			13, 855	970	3, 750	$250	1, 000	50
Shad			3, 750	188			124, 000	4, 960
Striped bass			4, 785	670	1, 000	70	2, 700	135
Suckers			27, 675	2, 214				
Sunfish			6, 475	518				
Weakfish					6, 000	180		
White perch			13, 050	1, 044	600	30	2, 459	49
Yellow perch			11, 680	934				
Miscellaneous fish			2, 200	154				
Terrapin	1, 000	$80						
Total	1, 000	80	204, 360	9, 182	11, 350	530	130, 959	5, 206

Species.	Middlesex.		Monmouth.		Ocean.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives							97, 350	$495
Black bass							1, 000	140
Bluefish			1, 000	$50			1, 000	50
Butter-fish			3, 000	150			3, 000	150
Carp							2, 000	160
Catfish							21, 340	1, 707
Eels			43, 150	2, 797	4, 500	$300	66, 255	4, 367
Flounders	1, 500	$60	29, 900	1, 247	54, 500	2, 180	85, 900	3, 487
Menhaden			29, 167	53			29, 167	53
Scup			2, 100	105			2, 100	105
Sea bass			1, 100	3			1, 100	3
Shad	12, 500	543	4, 000	240			144, 250	5, 931
Spots			6, 500	265			6, 500	265
Striped bass	2, 400	192	2, 550	274	1, 500	300	14, 935	1, 641
Suckers							27, 675	2, 214
Sunfish							6, 475	518
Tautog			2, 900	115	2, 300	69	5, 200	184
Weakfish	500	30	6, 000	305			12, 500	515
White perch			4, 900	319	5, 000	430	26, 009	1, 872
Yellow perch							11, 680	934
Miscellaneous fish	500	25	300	15	1, 400	42	4, 400	236
King crabs			20, 000	125			20, 000	125
Terrapin			848	318			1, 848	398
Total	17, 400	850	157, 415	6, 381	69, 200	3, 321	591, 684	25, 550

PENNSYLVANIA.

This State abuts on two important rivers tributary to Delaware and Chesapeake bays, respectively, and on one of the Great Lakes, and fishing with fyke nets is or has been prosecuted in each of these three bodies of water. The river fishery will be considered in this place, and the lake fishery in the chapter relating to the Great Lake basin. Pennsylvania ranks fifth among the States of this region as regards the extent of its fyke-net fishery; although a large number of nets are used, they are mostly of small size and the average catch per net is low. The fishery in the Delaware River is much more important than that in the Susquehanna; more men are employed, more nets are operated, and more fish are caught. In the Susquehanna, however, the nets are more costly and the average yield is greater.

The principal kind of fyke used in this State, in the Delaware River, is the drop fyke, which has already been described. It is particularly numerous in Philadelphia County, where the fishery is more important than that in any other county. The fykes are usually set from skiffs carrying one or two men, and are generally placed, about 16 feet apart, in strings. The outfit of a boat is from 10 to 100 nets. Almost the entire catch consists of catfish, which are sold dressed at 8 cents a pound. The fish lose about half their weight in dressing. The season extends from May 1 to October 20, during which time the nets are lifted once, twice, three times, or more frequently each week. Many of the fishermen lift only once a week. The average stock to a net in Philadelphia County is about $1.84. The fishery in the vicinity of Philadelphia owes its importance to the fact that the numerous vessels plying on the river would prevent the use of seines and gill nets.

In the falls of the Delaware River, below Lambertville, N. J., about a dozen fykes, each provided with a pair of long wings built of stones, were fished some years ago by four fishermen from New Hope, Pa. Catfish was the principal species taken.

In the Susquehanna River this fishery is much less important than it was some years ago. In 1880, 3,000 fyke nets were reported to be fished in summer, in the Susquehanna River between Havre de Grace and Columbia, for perch, rock, and catfish, but at the present time, owing to legal restrictions, the number fished commercially is less than 100, and the principal fish taken are carp, eels, and suckers.

The extent of the fyke-net fishery of Pennsylvania in 1891 is shown by counties in the following tables:

Fishermen.

Counties.	Number.
Bucks	23
Delaware	3
Lancaster	7
Philadelphia	24
York	3
Total	60

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Bucks	380	$1,330	25	$585
Delaware	70	140	3	60
Lancaster	43	260	7	84
Philadelphia	2,026	3,444	21	840
York	15	90	3	35
Total	2,534	5,264	59	1,604

Products.

Species.	Bucks.		Delaware.		Lancaster.		Philadelphia.		York.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	5,075	$26	......	......	......	......	......	......	......	......	5,075	$26
Carp	300	24	......	......	2,625	$131	......	......	875	$44	3,800	199
Catfish	5,025	352	5,000	$250	......	......	72,000	$2,880	......	......	82,025	3,482
Eels	3,100	218	1,000	55	3,225	194	19,000	855	1,075	64	27,400	1,386
Black bass	675	68	......	......	......	......	......	......	......	......	675	68
Shad	475	25	......	......	......	......	......	......	......	......	475	25
Suckers	12,750	811	......	......	5,025	125	......	......	1,675	42	19,450	978
Striped bass	970	96	......	......	......	......	......	......	......	......	970	96
Sunfish	1,625	98	......	......	......	......	......	......	......	......	1,625	98
White perch	2,225	135	......	......	......	......	......	......	......	......	2,225	135
Yellow perch	2,125	122	......	......	......	......	......	......	......	......	2,125	122
Other fish	850	44	......	......	......	......	......	......	......	......	850	44
Total	35,195	2,019	6,000	305	10,875	450	91,000	3,725	3,625	150	146,695	6,659

DELAWARE.

In proportion to the extent of the general fisheries, the fyke-net fishery of Delaware is of considerable importance, although very small as compared with that of adjoining States. It is carried on from the Delaware Bay and ocean sides of the State and also from that part drained by streams flowing into Chesapeake Bay.

The nets employed are generally of small size, of the style already designated as drop fykes; the average value is only a little over $2. The fish taken in greatest numbers are catfish, white and yellow perch, and eels. The average catch to a net is only about 80 pounds, and the average stock is only $4, many of the nets being used irregularly and for a short period each year. Drop fykes, with a large bow-shaped mouth, are fished at some places from September 1 to June 1, chiefly for catfish, which are sold mostly in Philadelphia and are usually dressed before shipment.

A few years ago, at Bombay Hook, 15 fykes, with an entrance 15 feet wide, were fished by two men for snapping turtles. The annual stock was $200, which represented 2,000 pounds of turtles. The latter weighed from 4 to 80 pounds, having an average weight of 12 pounds. They were sold in Philadelphia. In the Nanticoke River, in Sussex County, fykes 12 feet long, with the first hoop 6 feet in diameter and with 3 or 4 funnels, are used for shad, herring, perch, suckers, pike, and striped bass.

In the Indian River, which drains into the Atlantic south of Cape Henlopen, a number of fykes are used during the colder months, when they are lifted three times a week. The catch consists largely of perch.

In 1891 the fyke-net fishery of Delaware had the following extent:

Fishermen.

Counties.	Number.
Kent	8
Newcastle	11
Sussex	8
Total	27

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Kent	112	$259	8	$120
Newcastle	400	800	9	225
Sussex	55	202	8	80
Total	567	1,261	25	425

Products.

Species.	Kent.		Newcastle.		Sussex.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish	6,500	$390	13,700	$822	2,000	$100	22,200	$1,312
Eels	2,700	162	3,500	175			6,200	337
Shad					1,001	61	1,001	61
Striped bass	240	32	900	90	300	45	1,440	167
Suckers	200	8					200	8
White perch	1,700	89	2,500	125	5,000	310	9,200	524
Yellow perch					2,47	123	2,470	123
Other fish					2,380	59	2,380	59
Total	11,340	681	20,600	1,212	13,151	698	45,091	2,591

MARYLAND.

In the preceding general tables and discussion, the importance of the fyke net in this State has been shown. While New York has a larger aggregate catch on the coast and in Lake Ontario, the extent of the fishery on the Atlantic seaboard and coast rivers is much less than in Maryland. This is the fyke-net State par excellence. More nets are here employed, the nets are more generally used and distributed, and a larger variety of forms is met with than in any other State.

Fykes are found in fourteen counties in this State. They are most extensively employed in Baltimore, Cecil, Dorchester, Harford, and Somerset counties, which have over 1,000 nets each. The catch is most valuable in Kent and Cecil counties, where products worth over $10,000 are taken with this apparatus. The most prominent species taken are catfish, eels, white perch, yellow perch, pike, and striped bass, but a number of others have considerable importance.

The full extent of this fishery in 1891 is shown in the following series of tables. The figures for the individual counties are shown separately.

Fishermen.

Counties.	Number.
Anne Arundel	4
Baltimore	55
Caroline	18
Cecil	91
Charles	6
Dorchester	52
Harford	32
Kent	88
Prince George	4
Queen Anne	28
Somerset	45
Talbot	83
Wicomico	73
Worcester	16
Total	595

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Anne Arundel	22	$396	3	$60
Baltimore	1,781	6,113	48	648
Caroline	239	2,374	15	225
Cecil	2,923	5,626	61	915
Charles	24	96	3	75
Dorchester	1,470	4,153	37	666
Harford	1,140	4,010	31	620
Kent	211	3,856	66	1,122
Prince George	16	64	2	50
Queen Anne	74	1,435	21	336
Somerset	1,179	3,525	34	680
Talbot	579	2,888	69	966
Wicomico	708	3,467	61	733
Worcester	32	111	9	75
Total	10,398	38,114	460	7,171

Products.

Species.	Anne Arundel.		Baltimore.		Caroline.		Cecil.		Charles.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	12,500	$50			9,200	$88	45,800	$329		
Catfish	3,870	116	35,860	$1,669	5,500	120	61,125	2,445	1,020	$41
Eels			9,040	452	6,625	265	66,600	3,280	800	24
Pike	286	20	27,875	1,657	3,200	192	21,228	1,486	1,500	180
Shad					1,313	17	4,361	149		
Striped bass	3,800	380	1,520	128	4,643	325	3,525	282		
Suckers					4,600	138	7,400	222	1,080	43
White perch			37,243	2,039	1,500	90	35,100	1,925	360	54
Yellow perch	3,325	100	58,350	1,627	4,750	90	49,335	1,480	1,440	115
Other fish	2,900	84	8,500	265	1,760	52	10,350	310		
Terrapins									240	50
Total	26,681	750	178,388	7,837	43,091	1,407	304,824	11,908	5,940	507

Species.	Dorchester.		Harford.		Kent.		Prince George.		Queen Anne.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	23,400	$117			79,100	$760			5,600	$55
Catfish	7,430	260	48,000	$1,800	40,260	1,208	680	$27	27,200	854
Eels	29,700	1,188	28,600	1,430	1,100	35	200	16		
Pike	5,400	224	11,286	790	23,300	1,814	1,000	120	4,005	365
Shad	3,220	120			6,041	245				
Spots and croakers					1,550	77				
Striped bass	3,995	280	3,560	320	3,500	210			16,890	1,520
Suckers	9,433	258	5,667	170	2,500	75	720	29		
White perch	1,800	90	14,909	820	27,000	1,650	240	36	22,900	1,144
Yellow perch	6,430	225	14,625	585	66,650	3,568	960	77	26,600	943
Other fish	5,020	150	9,135	274	10,150	413			2,550	110
Terrapins							160	34	6,815	1,020
Total	95,828	2,912	135,782	6,189	261,151	10,055	3,960	339	112,560	6,011

Species.	Somerset.		Talbot.		Wicomico.		Worcester.		Total.	
	Pounds	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	17,400	$87	14,300	$71	32,900	$159			240,200	$1,716
Catfish	3,470	173	14,400	360	66,110	2,650			314,925	11,723
Eels	21,500	860	10,200	408	38,700	1,548	7,200	$288	219,765	9,794
Pike	2,800	168	1,964	108	3,500	210	1,400	84	108,744	7,418
Shad	2,541	87	7,441	255	3,570	120			28,487	1,023
Spots and croakers	1,560	70							3,110	147
Squeteague	2,450	98							2,450	98
Striped bass	3,200	160	17,500	1,050	39,500	2,765			101,633	7,420
Suckers	3,200	94	8,700	250	7,600	190			50,900	1,469
White perch	1,300	52	9,580	383	4,800	240	900	54	157,632	8,577
Yellow perch	4,800	144	6,182	185	9,610	335	1,000	50	254,057	9,524
Other fish	2,400	72	2,065	62	7,684	270	800	40	63,314	2,102
Terrapins									7,215	1,104
Total	66,621	2,065	92,332	3,132	213,974	8,487	11,300	516	1,552,432	62,115

Compared with 1880, the fyke-net fishery of this State seems to have greatly increased. In that year only 4,050 fykes, pots, and baskets, valued at $6,600, were employed, no separate figures for fykes being available. As has been seen, 10,398 fykes were used in 1891, having a value of $38,114.

While some forms of nets and methods of fishing are common to almost the entire State, others are more or less peculiar to different sections or counties. In a previous chapter descriptions of some of the fykes used have been given, and illustrations of a number of forms are presented. Some further references to the types of nets employed in this State and to the fishery in some of the important counties will be given.

In many places in Caroline, Dorchester, Talbot, and other counties, the name "fyke" seems to be understood as applying only to each hoop and the netting and funnel connected therewith, and is not generally used, the net being called a "set of fykes." The fyke proper is also known as the "pocket" in some localities—Talbot

County, for instance. When a leader is used it is commonly called "hedging," and the curved wings are usually designated "bays," or "fore bays," in allusion to the corresponding parts of a pound net.

Among the simplest fykes used in Maryland are those called drop fykes, perch fykes, and eel fykes. Drop fykes are named in allusion to the practice of dropping them from the side of a boat and buoying them like a lobster pot, instead of staking them, as is done with the more elaborate nets. Perch and eel fykes are so called because of the principal fish taken in them.

Drop fykes, such as are used in Cecil County, are worth from $1 to $2 each; they are 3 feet across the mouth, have 5 hoops and 2 funnels, and take yellow perch (called "yellow neds"), catfish, pike, suckers, eels, and a few flounders. Each net is weighted with a stone, and has a bridle which is buoyed by a cork; it is left down for a day or two and then pulled up by the bridle to be relieved of the fish. The season extends from February 1 to May 30 and from September 15 to December 15.

In Cecil County a form of net called a "perch fyke" is principally set for white perch and yellow perch, but also takes catfish, pike, and eels. It is usually provided with an arched entrance, instead of a circular one, and has a 2-foot opening, 4 or 5 hoops, and 2 or 3 funnels; the length of the net is 5 feet. The value is $1 to $3. In some places they are set only at intervals during the year, but in others they are fished the year round, being left under the ice in winter and tended through holes cut in the ice. They are often set in strings containing 25 or 30 nets at intervals of 25 feet; each net is kept in position by a stone weighing about 3 pounds. Perch fykes are also known as "gumbo fykes," or "jumbo fykes."

A form of fyke set especially for eels, and called an "eel fyke," is employed in some numbers in Cecil County. Catfish constitute a prominent part of the catch, for which reason the net is known in places as a "cattie fyke." The net consists of 4 or 5 hoops, usually has 2 funnels, but sometimes 3, and is 2½ to 5 feet long; the mesh is 2¼ inches stretch measure; the material used is No. 9 cotton twine; the entrance, which is bowed, is 12 inches high and 18 inches wide. The eel fyke is fished mostly in spring and fall. It is baited with suckers (called "mullet") and menhaden (called "bugfish").

One of the simplest fykes met with is used in Dorchester and other counties on the eastern shore of Chesapeake Bay. It consists of three hoops, 8, 6, and 4 feet in diameter, with a funnel extending from the first and second hoops. The hoops are about 6 feet apart, so that the fyke proper is about 18 feet long. It is provided with two wings, each from 30 to 60 feet long. Terrapin, striped bass, and perch are taken. A similar net, observed on the Nanticoke River, has wings only 18 feet long and is there called a "sink net"; it is fished under the ice in winter and catches principally striped bass and perch. A form of fyke (plate LXXIII, fig. 2) made on this principle, but with a funnel in each hoop, is used in Fishing Bay, where it is known as a "buckdart," and is set wholly for terrapin. Such nets are valued at $10 to $25 each. They are placed in a creek or cove so that the wings reach the shores. The season begins April 1 and ends June 1, and reopens September 1 and continues till November 1. In 1887 13 such fykes set on Taylor Island took $500 worth of terrapin, which sold for $20 a dozen. Crabs also are caught, but are usually not saved. Considerable quantities of wild ducks are sometimes secured and add to the income of the fishermen.

Perhaps the most elaborate style of fyke net used in this State is shown in plate LXXIX, fig. 2. It is employed in Dorchester, Wicomico, and other counties and in some places is the prevalent form. It is usually known as a "set of fykes." It consists of two separate bags arranged with the openings opposite each other and connected on one side by netting, while from the other side wings and leader diverge. Each bag is 18 feet long and has 6 hoops and 2 funnels, the largest hoop being 5½ feet in diameter, the smallest 4 feet, the gradation between the hoops being about 3 inches. The leader, made of netting with a 3½-inch mesh, is 120 feet long; the wings are about half that length or less. Striped bass, perch, shad, herring, catfish, eels, and pike are secured.

In Caroline County a fyke net made of wire bagging and net wings was used some years ago. The nets in this county are mostly the "set of fykes" just described.

The "set of fykes" is also used in Talbot County, where the fykes proper are called "pockets"; they are 12 to 18 feet long, with a 2½ or 3 inch mesh; there are 5 hoops, from 3 to 6 feet in diameter, and usually two funnels; the hedging is 50 to 75 yards long. In the Wye River region, small single fykes, 8 feet long and 2 feet in diameter, are used for herring.

In Queen Anne County fykes with a leader and straight or curved wings are the commonest form in use. In the Chester River the fykes are almost always set like pound nets, with "forebays" and "hedging." At Centerville a net with straight wings, a leader, and 5 hoops, is called a "set of fykes." The catch in this county consists chiefly of striped bass, yellow perch, catfish, herring, and pike; pike are said to very frequently escape after being caught.

The fykes set in the Potomac River are mostly similar to the ordinary winged nets of the eastern shore of Maryland, which have already been described. They are set in water 4 to 6 feet deep, usually in creeks, with the mouth toward the incoming tide. They are also sometimes set in strings across the bed of a creek or at the mouth of an inlet. Five to 8 nets are arranged side by side in a straight row, with about 25 feet of netting between each adjoining pair, and with a wing from 60 to 120 feet long extending from each end net, forming an obtuse angle with the line of nets and having an inward turn at the end. The nets employed in this river are set during the fall and winter and catch chiefly pike, catfish, eels, yellow perch, white perch, and suckers; terrapin or "sliders" are also caught in small numbers.

VIRGINIA.

The close proximity to Maryland, the similar topographical conditions, and the similarity of the fishes taken would seem to insure to Virginia a fyke-net fishery of similar importance and extent to that existing in the adjoining State. Such, however, is not the case; on the contrary, the number of these nets found in Virginia is only one-thirtieth that used in Maryland and the catch is correspondingly less. The principal feature regarding the fykes of Virginia is their relatively high value and large stock as compared with Maryland. While the average value of the nets in the latter State is less than $4, in the former it is about $17; and while the average value of the catch in Maryland is only $6 per net, in Virginia it is nearly $40.

Fykes are employed in 14 counties in this State bordering on the Chesapeake Bay and the numerous tributary rivers and bays. They are most numerous and most productive in York County, although Gloucester, James City, and Northampton counties have rather important fisheries. The nets used are in great part similar to those found in Maryland, and need not again be described. The prominent species taken are squeteague, striped bass, spots, croakers, shad, white perch, and catfish.

Reference has elsewhere been made to a method followed in this State of setting simple fykes at each end of a leader. Such an arrangement is found in the James and York rivers and elsewhere. In the lower James River fykes thus placed are fished for striped bass in the fall. In the York River they are set from September 1 to May 1, and are taken up three times a week. The leader or hedging varies from 10 to 40 fathoms in length and is 3 to 8 feet deep. The first hoop is 4 to 6 feet in diameter, and the last 1½ to 3 feet; the number of hoops is 3 to 5. The value of two such nets, with the connecting leader, is $30 to $50.

An unique style of trap, apparently peculiar to this State, is illustrated in plate LXXVII, fig. 3; it consists in the substitution of a fyke for the usual form of entrance to the pot of a pound net. Capt. N. Raynor, of Hampton, Va., in a recent personal communication to the writer regarding the fykes employed in that part of the Chesapeake, refers as follows to this form of net:

> In addition to the regular fykes, some of the fishermen use what they term a funnel-mouth pound; that is to say, a pound with a square head, but with the regular fyke funnels instead of the perpendicular [square] mouth usual to pounds. This style prevails in Back River. The size is much smaller than the pound net for shad, etc. The fishermen claim it will hold the fish much better. The cost of this trap, "rock" size, is from $30 to $50.

The three tables which follow indicate the extent to which the various counties were interested in the fyke-net fishery in 1891:

Fishermen.

Counties.	Number.
Accomac	2
Elizabeth City	2
Essex	3
Fairfax	8
Gloucester	11
Isle of Wight	14
James City	21
King and Queen	3
Nansemond	6
New Kent	6
Northampton	8
Prince William	2
Richmond	8
York	9
Total	98

Nets and boats.

Counties.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Accomac	3	$60	1	$15
Elizabeth City	4	200	2	30
Essex	18	270	3	50
Fairfax	32	128	4	100
Gloucester	38	475	9	100
Isle of Wight	28	420	14	195
James City	66	675	12	175
King and Queen	18	225	3	60
Nansemond	8	400	3	75
New Kent	10	125	3	60
Northampton	16	1,280	7	280
Prince William	8	32	1	25
Richmond	6	90	3	25
York	124	1,550	8	140
Total	379	5,930	73	1,330

Products.

Counties.	Alewives.		Catfish.		Flounders.		White perch.		Yellow perch.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Accomac					1,500	$30	3,500	$105		
Elizabeth City							4,500	135		
Essex	800	$8	1,500	$90	200	8	3,000	150	300	$9
Fairfax			1,200	48			400	60	2,080	166
Gloucester			5,400	162	4,200	210	2,900	116		
Isle of Wight	3,500	35	4,500	200			2,000	120		
James City			5,753	176			8,025	307		
King and Queen			7,956	229			3,672	110		
Nansemond	4,000	120					800	32		
New Kent			4,423	133			2,040	61		
Prince William			300	12			100	15	520	42
Richmond			8,000	320						
York					10,000	500				
Total	8,300	163	39,032	1,370	15,900	748	30,937	1,211	2,900	217

Counties.	Shad.		Spots and croakers.		Squeteague.		Striped bass.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Accomac							500	$20
Elizabeth City			5,500	$165	5,000	$150		
Essex	1,050	$27					2,800	196
Gloucester	3,500	90	10,500	315	7,500	225	1,650	165
Isle of Wight							3,000	300
James City			7,995	318	8,199	327	8,559	855
King and Queen							1,836	184
Nansemond	700	36	10,000	400	10,000	400	6,000	480
New Kent							1,019	102
Northampton	7,700	330			9,450	283	8,100	405
York	24,500	700	10,100	480	38,000	1,120	3,350	335
Total	37,450	1,183	44,095	1,678	78,149	2,505	36,814	3,042

Counties.	Suckers.		Other fish.		Terrapin.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Accomac	1,000	$30					6,500	$185
Elizabeth City	3,000	60					18,000	510
Essex	1,000	30	700	$21			11,350	539
Fairfax	1,600	64	2,080	237	240	$50	7,600	625
Gloucester							35,650	1,283
Isle of Wight			1,500	45			14,500	700
James City	1,056	32					39,587	2,015
King and Queen	3,168	95					16,632	618
Nansemond							31,500	1,468
New Kent	1,760	53					9,242	349
Northampton			8,600	172			33,850	1,190
Prince William	400	16	520	59	60	13	1,900	157
Richmond			4,000	200			12,000	520
York			11,100	333			97,050	3,468
Total	12,984	380	28,500	1,067	300	63	335,861	13,627

THE SOUTH ATLANTIC STATES.

The fyke-net fishery of this region is less important than in any other coast section, except the Gulf States where no fykes are employed. This is especially striking in view of the almost unlimited fishing-grounds to which this apparatus is adapted. In a recent report by the writer on the fisheries of the South Atlantic States attention was directed to the almost complete absence of fyke nets (and pound nets) from these States in the following words:

> A consideration of the forms of apparatus employed in the food-fish fisheries of the South Atlantic States shows that the use of seines and gill nets is so much more extensive than that of any other form, except in North Carolina, that all other apparatus is unimportant by comparison, and that some types which in other regions constitute a very prominent means of capture are entirely absent or only sparingly used in the greater part of the South Atlantic region. The pound net, for instance, is

> found practically only in one State, and the fyke net is employed only in very small numbers and in isolated localities. The possibility of introducing new forms which will develop the fishing resources, increase the income of the fishermen, and at the same time mitigate their labors, seems worthy of serious attention. Both the pound and fyke nets are adapted to the capture of almost every species of marine, fresh-water, and anadromous fish occurring in the region, and the topography of the shores is extremely favorable to their employment. Their inexpensiveness, as compared with seines, recommends them, and the possibility of employing them in connection with seine, gill-net, and other fisheries without special increase in the working force is an important consideration. (Report on the Fisheries of the South Atlantic States. Bulletin U. S. Fish Commission, XI, 1891.)

Fyke nets are at present found in only two of the South Atlantic States, viz, North Carolina and Georgia. They are more numerous and take larger quantities of fish in the former State, but yield the greater money returns in Georgia, as shown in the following statement of the extent of the fyke-net fisheries of this section in 1890:

Fyke-net fishery of the South Atlantic States.

States.	No. of fishermen.	Fyke nets.		Boats.		Products.	
		No.	Value.	No.	Value.	Pounds.	Value.
North Carolina	27	36	$384	4	$60	24,885	$716
Georgia	10	11	285	5	70	20,190	898
Total	37	47	669	9	130	45,075	1,614

NORTH CAROLINA.

Fykes are used in this State in only Dare and Sampson counties, and in these in very small numbers. The nets are of simple types and have a value of $5 to $25. The forms met with have from 2 to 5 hoops and have wings and leaders, or only wings.

In Dare County the nets are fished from Roanoke Island, and the catch consists chiefly of striped bass, squeteague, and mullet. The nets have an average value of $17. The fykes proper are from 4 to 7 feet long, have 5 hoops, and usually have leaders about 50 yards long. In Sampson County the nets are set in a branch of the Cape Fear River, and only fresh-water fish are caught. No boats are used, as owing to the shallow water the fishermen are able to set and lift the nets by wading. The nets are cheaper than those used in Dare County, having an average value of only $5. The yield is made up of perch, suckers, and catfish.

Of the 27 fyke-net fishermen reported in this State in 1890, 19 were in Sampson County, where 19 of the 36 nets were set. The fishery represented an investment of $444, while the catch was valued at $716. The quantities and values of the principal species taken were as follows:

Products of the fyke-net fishery of North Carolina in 1890, specified by species and counties.

Species.	Dare.		Sampson.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Catfish			3,000	$90	3,000	$90
Mullet	6,300	$36			6,300	36
Perch			5,000	245	5,000	245
Sheepshead	275	11			275	11
Squeteague	3,700	74			3,700	74
Striped bass	1,310	79			1,310	79
Suckers			4,000	140	4,000	140
Other fish	1,300	41			1,300	41
Total	12,885	241	12,000	475	24,885	716

GEORGIA.

Fyke nets are used in this State only in Chatham and Bryan counties, in the Savannah and Ogeechee rivers. Those in Chatham County are provided with leaders and wings, and have an average value of $34. In Bryan County the nets are smaller, with a value of only $5. The principal fish taken are alewives, catfish, and striped bass. The 8 nets used in Chatham County in 1890 were valued at $270, were operated with 4 boats, and were tended by 8 men; the catch was 16,000 pounds, which yielded the fishermen $743. In Bryan County the 3 nets were worth $5, and were fished in one boat by 2 men; 4,190 pounds of fish were taken, worth $155. The table shows the extent to which the several species and the two counties were represented in the catch.

Fyke-net catch of Georgia in 1890.

Species.	Chatham.		Bryan.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	8,000	$340			8,000	$340
Catfish	5,000	163	2,515	$88	7,515	251
Striped bass	3,000	240			3,000	240
Other fish			1,675	67	1,675	67
Total	16,000	743	4,190	155	20,190	898

THE PACIFIC STATES.

Fyke nets are uncommon on the Pacific coast. They are not used in the fisheries of Washington and Oregon, and in California are restricted to two rivers emptying into San Francisco Bay. The scarcity of these nets in the Pacific States may be explained by the facts, (1) that they are less adapted to the capture of salmon, sturgeon, and other large fish, to the pursuit of which the energies of the fishermen have chiefly been directed, than are the wheels, seines, and gill nets; (2) that the general demand for small fish is as yet so limited that no special apparatus or attention has been devoted to it. With the increase in population in the coastal regions of the Pacific States fyke nets are likely to come into extensive use.

CALIFORNIA.

Fyke nets have been in use in this State for a great many years. The history of their introduction is unknown to the writer, but it would seem that they must have been taken in very soon after, if not coincident with, the advent of the gold-seekers in 1849, for their use is recorded as early as 1852. Twenty years ago more nets were employed, but it is doubtful if the fishery has ever been more productive than at the present time.

Fyke nets are fished only in the San Joaquin and Sacramento rivers; in the latter stream their use dates at least as far back as 1852, as has been noted, but in the former river their advent has apparently been recent. All the nets are operated by fishermen who are engaged in taking fish by other means. The nets are described as having 4 hoops, being provided with wings, and resembling the kind figured in plate LXXIII, fig. 2; their value is about $20 each. Of the 49 used in 1892, 24 were fished in the San Joaquin River at or near Jersey Landing, in Contra Costa County, and at Black Diamond, near its mouth, in the same county; the others were set in the Sacramento River, in the vicinity of the city of the same name and elsewhere along the course of the stream. The San Joaquin River fishermen represent three countries—Greece, Italy, and the United States—although the Greeks and one Italian have become citizens of this country; in the Sacramento River the fishermen are all Chinamen. Sailboats are used to lift the nets in the San Joaquin River and rowboats in the Sacramento River.

The fishes taken in the fyke nets in the Sacramento and San Joaquin rivers represent a variety of species, among which the following may be mentioned, the common names given being those used by the fishermen: Carp (*Cyprinus carpio*), introduced; catfish (*Ameiurus nebulosus*), introduced; chub (*Mylocheilus caurinus*); hardhead (*? Mylopharodon conocephalus*); perch (*Archoplites interruptus* and *Hysterocarpus traski*); split-tail (*Pogonichthys macrolepidotus*). In addition to the foregoing, the following fish were, a number of years ago, reported to be taken in fyke nets in the Sacramento River: Sacramento pike (*Ptychocheilus oregonensis* and *P. harfordi*); in recent years these may have been returned under the name "chub," which is more appropriate than "pike;" sucker (*Catostomus occidentalis*); sturgeon (*Acipenser transmontanus*); herring (*? Clupea mirabilis*).

The yield of the California fyke nets is relatively large, the average per net being much greater than in most of the other States. In the San Joaquin River the average catch per net is 1,893 pounds, valued at $55; in the Sacramento it is 5,824 pounds, worth $150. It is interesting to observe that at the present time about three-fourths of the output of the State consist of two introduced fish, the carp and the catfish, which make up the entire catch in the San Joaquin. Twelve men engaged in this fishery in Contra Costa County and 20 in Sacramento County. They used 16 boats, valued at $1,050, of which 6, worth $900, were used in the former county. The 49 nets operated had a value of $980; 24 of these, worth $480, were set in Contra Costa County. The aggregate catch amounted to 194,647 pounds, for which the fishermen received $5,116. The extent to which the different species are represented in each county is as follows:

Product of the fyke-net fishery of California in 1892, specified by species and counties.

Species.	Contra Costa.		Sacramento.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Carp	19,955	$599	22,160	$775	42,115	$1,374
Catfish	29,596	745	84,979	2,125	114,575	2,870
Chub			1,054	21	1,054	21
Hardhead			17,512	350	17,512	350
Perch			2,834	170	2,834	170
Split-tail			16,557	331	16,557	331
Total	49,551	1,344	145,096	3,772	194,647	5,116

The fyke-net fishery during the past few years shows a small general increase annually. The product has advanced from 146,309 pounds in 1889 to 194,647 pounds in 1892, this increase being made up almost wholly of carp and catfish. The following table exhibits the yearly fluctuations in the catch of the different species:

Comparative table showing the fyke-net catch of California from 1889 to 1892, inclusive.

Species.	1889.		1890.		1891.		1892.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Carp	31,614	$1,049	34,722	$1,158	35,662	$1,183	42,115	$1,374
Catfish	79,937	2,015	87,744	2,193	97,899	2,442	114,575	2,870
Chub	1,265	25	906	18	1,230	25	1,054	21
Hardhead	14,440	289	16,160	323	16,736	335	17,512	350
Perch	1,941	116	2,745	165	2,149	129	2,834	170
Split-tail	17,112	342	14,559	291	15,660	313	16,557	331
Total	146,309	3,836	156,836	4,148	168,836	4,427	194,647	5,116

Writing on the fyke-net fishery of the Sacramento River in 1873,* Mr. Livingstone Stone makes the following remarks, which are interesting in themselves and for the opportunity afforded for comparison with recent years:

> The fyke nets have a mesh of 2¼ inches. There were in the winter of 1872-73 85 fyke nets on the Sacramento at Rio Vista. They are stationary, of course, and are examined every twenty-four hours. All the kinds of fish that are found in the river are caught in these nets. Mr. John D. Ingersoll, a prominent fyke fisherman of Rio Vista, informed me that the daily catch for 20 nets is now about 75 pounds of fish. They include chubs, herring, perch, viviparous perch, sturgeons, hardheads, split-tails, Sacramento pike, suckers, crabs. Of these the perch, pike, and sturgeon are the best food-fishes, though all the species named are sold in the market.
>
> There has been a vast decrease in the returns of the fyke nets during the last twenty years. In 1852 and 1853 they used to catch 700 or 800 pounds a day in one fyke net. An average of 250 pounds a day for one net at Sacramento City was usually expected in those times. The present catch of 75 pounds a day in 20 nets certainly presents an alarming contrast. The fyke-net fishing is done wholly by white men, I believe, the Chinese fishermen being ruled out by force of public sentiment. The fyke nets are usually visited early in the morning of each day, and the catch is sent down to San Francisco by the noon boat. The fyke-net fishing begins in November and is continued until May. The best fishing is when a rise in the water drives the fish inshore, where the fyke nets are placed. During the summer months the water is warmer, the fish are poor, and the fishing is discontinued.
>
> On the 27th of February, 1873, I went the rounds of Mr. Ingersoll's set of fyke nets with him. We visited 20 nets, but as some of them had not been examined for over twenty-four hours the yield was supposed to be equivalent to one day's fishing for 30 nets. The nets had four hoops each and 14-foot wings. We took out about 120 pounds of fish in all. Hardheads were the most numerous, and the Sacramento pike next. Mr. Ingersoll said that perch used to rank second in abundance in fyke-net fishing, the average for 30 nets being 200 or 300 pounds a day, but the perch were quite insignificant in numbers on this day. We found in the nets 7 small viviparous perch and 2 small sturgeon. I learned also that mink, beaver, and otters are sometimes caught in the nets. In 1872 Mr. Ingersoll caught 8 minks, 2 beavers, and 1 otter in his fyke nets.

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*Report of Commissioner of Fish and Fisheries, 1873-74 and 1874-75, pp. 383-384.

THE GREAT LAKES.

In the States bordering on the Great Lakes the fyke net is one of the most important means of capture, and, taking the entire region into consideration, yields larger quantities of fish than any other geographical section except the Middle Atlantic States. The fishery is most extensive in Ohio, the shores of which State are especially well adapted to the use of fykes; the order of importance of the other States is Michigan, Wisconsin, and New York. Minnesota, Illinois, Indiana, and Pennsylvania have no commercial fisheries carried on with this form of apparatus. The features of the Great Lakes which render the region well adapted to fyke-net fishing and have resulted in the extensive fishery of this kind there prosecuted are an abundance of fish in the shore waters and the existence of numerous coves, bays, creeks, etc., along the borders of the lakes especially suited to fyke nets because of the shallow water and the protection afforded from storms.

The extent of the fyke-net fishery of the Great Lakes specified by States is shown in the following tables relating to the year 1890:

Fishermen.

States.	Number.
Michigan	231
New York	74
Ohio	156
Wisconsin	112
Total	573

Nets and boats.

States.	Fyke nets.		Boats.	
	No.	Value.	No.	Value.
Michigan	446	$12,030	102	$2,257
New York	684	9,822	66	2,318
Ohio	1,110	63,650	139	14,045
Wisconsin	728	11,364	66	5,930
Total	2,968	96,866	373	24,550

Products.

Species.	Michigan.		New York.		Ohio.		Wisconsin.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bass	11,233	$949	72,353	$1,845	82,085	$4,504	17,810	$890	183,481	$8,188
Catfish	43,100	1,132	400,273	10,484	346,250	6,920			789,623	18,536
Eels			56,336	2,177					56,336	2,177
Herring	1,100	12					332,550	4,434	333,650	4,446
Perch	843,096	11,490	170,645	3,111	283,670	2,240	418,900	8,838	1,716,311	25,679
Pike and pike perch	170,240	8,563	73,770	3,340	676,015	19,045	155,060	6,213	1,075,085	37,161
Suckers	367,555	7,051	76,320	1,056			335,410	3,887	779,285	11,994
Trout	1,000	40					14,480	605	15,480	645
Whitefish	3,400	150					6,285	315	9,685	465
Other fish	164,750	1,884	49,830	548	1,006,925	7,150	40,750	1,019	1,262,255	10,601
Turtles					25,705	514			25,705	514
Total	1,605,474	31,271	899,527	22,561	3,420,650	40,373	1,321,245	26,201	6,246,896	120,406

Owing to the fact that both Michigan and Wisconsin have a frontage on more than one of the Great Lakes, and that the conditions differ somewhat in each lake, a consideration of the subject by lakes presents greater interest than the preceding arrangements, and is, besides, the more natural way in which to discuss the matter.

The fyke-net fishery of Lake Erie is very much more important than that of any of the other lakes; 173 fishermen were here employed in 1890, 1,175 nets were used, 2,507,650 pounds of fish were taken, and $41,893 resulted from the sale of the fish. The fyke-net fishery of Lake Michigan is second in extent, with 113 fishermen, 731 nets, and 1,311,045 pounds of fish, worth $25,558. Lake Huron ranks third, and in the year named was ascertained to have 81 fishermen and 221 nets, and to have yielded 1,088,751 pounds of fish, valued at $23,156. Following Lake Huron is Lake Ontario, with 74 fishermen, 684 nets, and 899,527 pounds of fish, which sold for $22,561. Lake St. Clair, with the two rivers connected with it, had 124 fishermen and 148 nets, which yielded 415,348 pounds of fish, for which $6,068 was received. The least important fishery of this kind is found in Lake Superior, which had only 8 fishermen and 9 nets, while the catch was only 24,575 pounds, valued at $1,170.

The following series of tables shows, by States, the extent of the fyke-net fishery of each lake:

Fishermen.

Lakes.	Michigan.	New York.	Ohio.	Wisconsin.	Total.
Superior	4			4	8
Michigan	5			108	113
Huron	81				81
St. Clair	124				124
Erie	17		156		173
Ontario		74			74
Total	231	74	156	112	573

Nets and boats.

Lakes.	Fyke nets.									
	Michigan.		New York.		Ohio.		Wisconsin.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Superior	4	$80					5	$333	9	$413
Michigan	8	285					723	11,031	731	11,316
Huron	221	6,385							221	6,385
St. Clair	148	4,480							148	4,480
Erie	65	800			1,110	$63,650			1,175	64,450
Ontario				$9,822					684	9,822
Total	446	12,030	684	9,822	1,110	63,650	728	11,364	2,968	96,866

Lakes.	Boats.										Total investment.
	Michigan.		New York.		Ohio.		Wisconsin.		Total.		
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	
Superior	3	$250					4	$180	7	$430	$843
Michigan	3	70					62	5,750	65	5,820	17,136
Huron	62	1,202							62	1,202	7,587
St. Clair	24	510							24	510	4,990
Erie	10	225			139	$14,045			149	14,270	78,720
Ontario			66	$2,318					66	2,318	12,140
Total	102	2,257	66	2,318	139	14,045	66	5,930	373	24,550	121,416

Products.

Lakes.	Michigan.		New York.		Ohio.		Wisconsin.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Superior	3,875	$135					20,700	$1,085	24,575	$1,170
Michigan	10,500	392					1,300,545	25,166	1,311,045	25,558
Huron	1,088,751	23,156							1,088,751	23,156
St. Clair	415,348	6,068							415,348	6,068
Erie	87,000	1,520			2,420,650	$40,373			2,507,650	41,893
Ontario			899,527	$22,561					899,527	22,561
Total	1,605,474	31,271	899,527	22,561	2,420,650	40,373	1,321,245	26,201	6,246,896	120,406

LAKE SUPERIOR.

The fyke has never attained any prominence as a means of capture in this lake, and is now the least important form of apparatus there employed. As shown in a previous table, only 9 fyke nets were used in the entire lake in 1890; of these, 5 were set in Ashland County, Wis., and 4 in Houghton and Ontonagon counties, Mich. In 1891 the number of nets employed in Wisconsin was increased to 11, valued at $710. Fykes have at times been used in other parts of this lake, but their use has never been extensive. In 1883 some nets were experimentally used in Baraga County, Mich., for herring, but they were not effective and the fishery was discontinued. In 1885 a few fykes were fished for wall-eyed pike and pickerel in Keweenaw Bay at the mouth of Portage River, but appear to have been abandoned in recent years. The chief fish now caught in the fykes is the pike perch, which, in 1890, constituted more than half the yield. Trout and whitefish are also taken in small quantities in Wisconsin. The result of this fishery in 1890 was as follows:

Products of the fyke-net fishery of Lake Superior.

Species.	Pounds.	Value.
Pike perch	13,200	$660
Trout	3,500	175
Whitefish	4,000	200
Other fish	3,875	135
Total	24,575	1,170

LAKE MICHIGAN.

The fyke-net fishery of Lake Michigan ranks next to that of Lake Erie in importance. The nets are set in small numbers on the eastern side of the lake, but their use there is very limited, and the fishery appears to be decreasing; on the western shore they constitute a prominent means of capture, being especially important in Green Bay and vicinity. Some localities in which fykes were reported in 1885 appear to have given up that method of fishing as a commercial enterprise in 1890, while in others nets have been introduced.

The meager references to this fishery in 1880 found in the report on "The Fisheries and Fishery Industries of the United States" indicate a much less extensive use of fyke nets than in 1885 or 1890. In 1885 there were 362 fyke nets, valued at $6,105, set in the waters of this lake. These were most numerous in the Green Bay region, where about five-sixths of the number mentioned were employed. What was written regarding the fyke net in this lake in 1885 applies in great part to the present time and may be appropriately quoted, both for the information conveyed and the opportunity offered for making comparison with present conditions. The "Review of the Fisheries of the Great Lakes" contains the following references to this lake:

> Fyke fishing in Lake Michigan is confined largely to the waters at the southern end of Green Bay, in the vicinity of the city of that name, where they are fished extensively in the shoal waters and along the borders of the marshy flats. They are used to a small extent in other localities, but not in sufficient numbers to render the fishery important.
>
> Sixteen of the twenty-seven fykes owned in Oconto County belong at Pensaukee, and the remainder, with two exceptions, at Little Suamico. The kind used has a hoop 5 feet in diameter with wings 82 feet long and a 165-foot leader. They are set in 6 to 10 feet of water in winter and in still shoaler water in summer. They are fished from the late winter to the early summer for perch, suckers, black bass, pike, and pickerel.
>
> The fyke net was first introduced into the fisheries of the region between Suamico and Green Bay City, Brown County, Wis., about twenty years ago, although prior to 1880 it was a rare occurrence for anyone to make a business of fishing with such apparatus. Scores of them are now in use, belonging usually to the gill-net or seine fishermen, though in some cases their owners are persons who do no other fishing. Occasionally single fykes are fished for pleasure or home supply.
>
> Those now used are from 4 to 6 feet in diameter at the mouth and have two funnels. The hearts contain 24 to 30 feet of netting each, and the leaders are 200 feet long, with a 4-inch mesh. Although the cost of a new one is $30 or $35, the average value of those actually in use can not be placed higher than $15 or $20. A small scow, 15 feet long, with a 4-foot beam, is usually employed in setting and lifting the nets. It is 3 feet wide at the bow and 2½ feet at the stern. It has a centerboard, with a box 3½ feet long, nine knees, a bottom rounding up at stem and stern, and a place to step mast forward. It is worth $12 or $15 when new. In those cases in which fykes are owned by pound-net fishermen they are fished from ordinary pound boats. They are set particularly in the mouth of Duck Creek, but also in the Fox River and the intervening sloughs along the bay shore. Each man fishes his own nets, without needing anyone to assist him. If the weather is bad he tends half his nets each day, but otherwise he lifts the whole number, usually about ten. The season extends throughout the entire year, with the exception of July and part of August. In winter the fykes are fished through holes cut in the ice. All the species common to the region are taken. The most successful fisherman obtained in 1884 nearly $600 worth of fish in twelve fykes.
>
> Between Bay Settlement, in Brown County, and Namur, in Door County, Wis., twenty fyke nets are fished throughout the year, on the shore between Green Bay and Wequiock, by four professional fishermen, each of whom operates five nets. The nets are about 10½ feet long, with three or four hoops from 3 to 8 feet in diameter. The catch consisted of about 30,000 pounds of perch, pike, pickerel, herring, and suckers, valued at $500.
>
> At Little Sturgeon, in Door County, eight men, who gave their principal attention to the pound-net and gill-net fisheries, fished eighteen fyke nets, worth $350, from six weeks to two months in the spring, and occasionally in the summer and fall. Most of the nets are 20 feet long, with hoops 3 to 3½ feet in diameter and a 3-inch mesh. They are set close to the shore, the stakes being driven in 6 feet of water. The catch in 1885 consisted of 24,900 pounds of perch, whitefish, suckers, bass, catfish, and pike, valued at $630.
>
> There were only ten fyke nets owned along the shore of Door County between Death's Door and Sturgeon Bay in 1885, six of which were at Ephraim and four near Egg Harbor. The framework of these nets is composed of two or three iron hoops and a rectangular iron frame called the door. This is covered with netting, which is extended to form two long wings or leaders, one on each side, and there is a tunnel inside the door through which the fish are conducted into the interior. In a specimen from which measurements were taken the dimensions of the door were 5 by 2 feet and the wings were each 83 feet long. There were two hoops about 4 feet in diameter, and one 3½ feet, with a wooden ring 1 foot in diameter at the inner end of the tunnel. The mesh was 4½ inches in the wings and 2½ inches in the body of the trap. The other fyke nets are of different sizes, some smaller than the above and some much larger. The fishery is of very little importance, and in the summer and fall of 1885 no more than four of the nets were used. Two of the fyke-net crews from Little Sturgeon fish during a portion of the year from Hat Island, off Egg Harbor. The catch consisted exclusively of bass and perch and amounted to 1,900 pounds, valued at $95.
>
> Although formerly of considerable importance in Milwaukee County, Wis., this fishery has of late deteriorated, chiefly on account of the polluted condition of the water flowing from the river, at the

> feet. The second funnel has an aperture of 3 feet at one end, and is closed at the other. Some of the fykes have wings 12 feet long on each side of the mouth, extending at an angle of 45 degrees. The size of mesh in the funnels is 1½ inches, and in the leader and wings 3 inches. The fish are removed by lifting the small end of the second funnel, which is closed with a puckering string, and taking them out with a dip net. In the winter the nets are set at some distance below the surface, in order that they may not be frozen in.
>
> There are 7 fyke-net fishermen, whose 5 boats are worth $50, their 43 fykes $382, and their minor apparatus and accessories $30. The products amounted to about 85,000 pounds, worth $2,400.

The fishery in Maumee Bay was referred to as follows:

> The fyke nets of Maumee Bay are much larger and better than those about Monroe. They are somewhat similar to the small pound nets and are quite as effective. Instead of wings they have a a leader and set of hearts. The leader is 30 to 70 fathoms long, the hearts 8 to 14 fathoms long, and the bowl or pocket 12 to 14 feet long. The mesh is 4 to 5 inches in the leader, 3 inches in the hearts, and 2½ inches in the bowl. Their value ranges from $25 to $50 each. The total number in Maumee Bay was 39, worth $1,710. There is none in the river or along this part of the coast. They are fished in the spring and fall, and occasionally in winter.

It was recorded of the fyke-net fishery of Ottawa County, Ohio, that—

> Three dozen fyke nets are fished in the mouth of Toussaint Creek in winter by the fishermen of that vicinity. The fykes proper are 14 feet long, the hearts 27 feet, and the leaders 165 feet. The size of mesh is 3 inches in the leader and hearts, and 2 inches in the fyke or bowl. In Portage River 40 fyke nets are used near the seining beaches, sometimes in winter but usually during the spring and fall, by men who give most of their time to other fisheries.

The following reference was made to the important fishing region embracing Sandusky Bay, the peninsula, and the Bass and other islands:

> On the outer shores of the peninsula and of Cedar Point and about the islands the most abundant species are whitefish and herring, but in the bay these do not occur, and the objects of pursuit are principally perch, saugers, bass, bullheads, and other species characteristic of the bays and river mouths. Pound nets are the most popular form of apparatus in the former section, where their number exceeds 300, though thousands of gill nets are fishing in the vicinity of the islands, and eight steam tugs and a large number of sailboats are devoted to this branch of the industry.
>
> All the fishing of the bay, with the exception of a little seining at the western end, is by means of fykes and small pound nets, which dot its shallow waters to the number of nine or ten hundred. Several seines are fished from the peninsula, both on the lake and the bay sides, and the fyke nets so numerous in the bay are also found in considerable numbers on the lake shore, though not used to any extent upon the islands. On the northern part of the peninsula, in the crotch between its two arms, are three marshy inlets with a total area of several thousand acres, which for about fifteen years have supported fyke-net fisheries of some importance. At present 107 nets are fished here by eight fishermen from the beginning of September to the 1st of May. The catch consists principally of bullheads and sunfish in fall, of bass in winter, and of grass pike in spring, with a large mixture of perch at all seasons. The fyke nets of the island region are mostly made of second-hand twine. The fyke proper, or pot, is 20 feet long, the hearts are 48 feet long, and the leaders, from 150 to 300 feet long. The size of the mesh is 4½ inches in the leader, 4 inches in the hearts, and 2½ inches in the pot.

LAKE ONTARIO.

In proportion to the extent of its general fisheries, there is no lake in which the fyke net is of greater importance than in Lake Ontario. An investigation* of the fisheries of this lake, conducted by the writer in 1891, disclosed the fact that the products of the entire industry in 1890 amounted to 3,446,448 pounds, valued at $124,786, while, as has been stated, the fyke-net catch alone was 899,527 pounds, having a value of $22,561; more than a fourth of the quantity and nearly a fifth of the value of the catch thus represented the output of the fykes.

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* Report on an Investigation of the Fisheries of Lake Ontario. Bull. U. S. Fish Commission, 1890.

The following table gives the quantity and value of the principal fishes taken in Lake Erie in 1890:

Products of the fyke-net fishery of Lake Erie.

Species.	Michigan.		Ohio.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black bass	500	$30	82,085	$4,504	82,585	$4,534
Catfish	30,000	750	346,250	6,920	376,250	7,670
Perch	20,000	200	283,670	2,240	303,670	2,440
Pike	1,980	99	314,440	15,193	316,420	15,292
Saugers	8,000	240	360,855	3,816	368,855	4,056
Wall-eyed pike	1,520	76	720	36	2,240	112
Other fish	25,000	125	1,006,925	7,150	1,031,925	7,275
Turtles	....	....	25,705	514	25,705	514
Total	87,000	1,520	2,420,650	40,373	2,507,650	41,893

The fyke-net fishery of Lake Erie is more extensive than at any previous time. While no figures exist for making detailed comparisons between its present and past importance, some notes relating to the years 1880 and 1885 can be presented, and for the latter year the number and value of nets can be shown.

Of Maumee Bay it was stated in 1880 that "a few fyke nets are in use for catching 'panfish,' but their products are of no considerable extent." On the shore of Monroe County, in the same year, there were 14 fishermen using 35 fykes. Only 50 nets were reported in the Sandusky region. Between Locust Point and Ottawa 36 nets were in use, and at Huron 20 were noted.

In 1885, when a comprehensive investigation of the methods and statistics of the fisheries of this lake was made by the U. S. Commission of Fish and Fisheries, the number of fyke nets employed was 1,069, valued at $62,148, distributed as follows:

Fyke nets employed in Lake Erie in 1885.

Sections.	No. of nets.
Monroe County, Mich	43
Maumee Bay, Ohio	39
Locust Point to Port Clinton, Ohio	76
Sandusky Bay and the outlying islands, Ohio	893
Cuyahoga County, Ohio	1
Lake and Ashtabula counties, Ohio	12
Erie County, Pa	5
Total	1,069

Of the 1,021 nets credited to Ohio, 893 were set in Sandusky Bay and around the islands lying off that region. The following notes on the fisheries of the principal regions are taken from the report* already quoted. Referring to Monroe County, Mich., which occupies the extreme western end of the lake, it was stated that—

> Between October 15 and April 15 a number of fyke nets are fished for the same species as are taken in the seines [bullheads, black bass, rock bass, perch, pike perch, grass pike, suckers, and herring]. They are located as follows: Six in Huron River near its mouth, 16 within the mouth of Swan Creek, and 15 in Plum Creek and Pleasant Bay. Each fyke consists of two staked and anchored funnels of netting, each 12 feet long, one opening into the other, and a 190-foot leader. The first funnel has a mouth 4 feet in diameter and an opening at the small end of the diameter of 1½

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* Review of the Fisheries of the Great Lakes.

mouth of which the nets were set. In 1885 a few small fykes, with 4-foot hoops, were fished under the ice by men engaged at other times in more profitable fishing. In 1866 an attempt was made to employ a fyke net far out in the lake at the end of a gang of gill nets. The results were unsatisfactory, owing, it is thought, to the fact that the net had no wings. There seems no reason to doubt that fykes provided with wings and properly weighted to maintain the hoops in a vertical position could be profitably employed on all the lakes in connection with the offshore gill-net fisheries.

The fyke-net fishery of this lake in 1890 was carried on by 113 men; 731 nets, valued at $11,316, were set; 65 boats, worth $5,820, were used, and products to the value of $25,558 were obtained. Brown County, Wis., has the most important fishery of this kind in the lake; in the items of persons employed, number of nets used, quantity and value of catch, it surpasses the combined interests of all the remaining counties. The extent of the fishery, specified by counties, is shown in the following table:

Fyke-net fishery of Lake Michigan.

States and counties.	No. of fishermen.	Fykes.		Boats.		Products.	
		No.	Value.	No.	Value.	Pounds.	Value.
Michigan:							
Manistee	3	2	$225	2	$60	6,200	$238
Muskegon	2	6	60	1	10	4,300	164
Wisconsin:							
Brown	58	524	8,060	31	3,125	949,340	18,430
Door	31	96	1,340	17	1,810	119,500	2,592
Marinette	6	8	116	5	240	16,005	310
Oconto	13	95	1,515	9	575	215,700	3,834
Total	113	731	11,316	65	5,820	1,311,045	25,558

The principal fish taken in fykes in this lake is the yellow perch, which constitutes about one-third of the yield. Pike, pike perch, herring, and suckers are also prominent factors in the catch. Bass are taken in considerable quantities, and trout and whitefish are secured in small numbers in suitable situations. The output of the different species is as follows:

Products of the fyke-net fishery of Lake Michigan.

Species.	Michigan.		Wisconsin.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bass	1,500	$60	17,810	$890	19,310	$950
Herring	100	2	332,550	4,434	332,650	4,436
Perch	800	24	418,900	8,838	419,700	8,862
Pike and pickerel	100	4	141,860	5,553	141,960	5,557
Suckers			335,410	3,887	335,410	3,887
Trout	1,000	40	10,980	430	11,980	470
Whitefish	3,000	120	2,285	115	5,285	235
Other fish	4,000	142	40,750	1,019	44,750	1,161
Total	10,500	392	1,300,545	25,166	1,311,045	25,558

LAKE HURON.

In this lake fyke nets are employed only in Saginaw Bay and River, where they are an important form of apparatus. From an early period the fyke has been used in this locality, and, with the seine, it antedated the pound net by a number of years, the latter net having been introduced in 1860. In 1885, 499 fyke nets, valued at $22,910, were ascertained to be fished in the bay and river, and in 1890 the number was 221, worth $6,385. The principal fishing now done in the river is carried on with fykes, called "gobblers." These nets are also set in some numbers in the bay at the mouths of the several small rivers entering it. The nets are made after the model of the Lake Erie pound net, the difference being that the bowl of the pound is replaced by the pot of the fyke. They are mostly used by men who also have pound nets. The fishing season extends from October 15 to April 15, during the whole of which time greater or less quantities of the different fishes are taken; but the largest catch of perch is made during the winter, while the pickerel and suckers, which are the next important species, occur in greatest abundance in the spring, about the time when navigation is resumed. The other species comprised in the fyke-net catch are black bass, catfish, and pike perch.

Eighty-one men tended the fyke nets used in Lake Huron in 1890; 62 boats, valued at $1,202, were employed, and the catch consisted of 1,088,751 pounds of fish, valued at $23,156, apportioned among the various species as follows:

Products of the fyke-net fishery of Lake Huron.

Species.	Pounds.	Value.
Black bass	7,650	$765
Catfish	5,100	153
Herring	1,000	10
Perch	558,446	8,021
Pike and pickerel	106,000	6,330
Suckers	367,555	7,051
Whitefish	200	10
Other fish	40,800	816
Total	1,088,751	23,156

LAKE ST. CLAIR.

This large, shallow dilatation of the St. Clair River, lying between Michigan and Canada, with its extensive grassy flats and its great abundance of small fishes, to the capture of which the fyke net is specially adapted, has a fyke-net fishery whose importance is relatively great in comparison with the size of the lake, the extent of the other fisheries, and the small number of nets used. The lake is no doubt capable of sustaining a much larger fishery of this kind, and in future many more of the cheap but efficient fyke nets will probably be employed.

The fishery in 1890 was less extensive than in 1885. The table which follows shows various phases of its extent in the first-named year, the figures being given separately for the two counties in Michigan in which the fishery is carried on.

Fyke-net fishery of Lake St. Clair.

Counties.	No. of fishermen.	Fykes.		Boats.		Products.	
		No.	Value.	No.	Value.	Pounds.	Value.
Macomb	116	133	$4,010	16	$350	369,850	$5,256
St. Clair	8	15	470	8	160	45,498	812
Total	124	148	4,480	24	510	415,348	6,068

The principal species taken are yellow perch, pike, pike perch, and catfish. More than half the quantity and value of the yield is made up of perch. A small quantity of black bass and whitefish is caught. Other minor species entering into the production are suckers and sunfish.

Products of the fyke-net fishery of Lake St. Clair.

Species.	Pounds.	Value.
Black bass	1,583	$94
Catfish	8,000	229
Perch	263,850	3,245
Pike and pike perch	50,640	1,814
Whitefish	200	20
Other fish	91,075	666
Total	415,348	6,068

LAKE ERIE.

The general shoalness of this lake, especially in the western part, makes the water very well adapted to fyke-net fishing, and is the cause of the prominence which the fyke net has attained as a means of capture. The lake has also an abundance of bottom fishes, such as pike and bullheads, to the capture of which the fyke is well suited. At times the fishery has been prosecuted in all the States bordering on the lake, but at present it is confined to Michigan and Ohio. In 1885 a small fishery was reported in Pennsylvania, and at an earlier period fyke nets were used in New York, but their use has never been extensive in these States. Even in Michigan the fishery is comparatively unimportant, and it is only in Ohio that it is conspicuous among the other fisheries, and, as already stated, is more prominent than in any other lake State.

The fyke-net fishery of this lake in 1890, specified by States and counties, is shown in detail in the following table:

Fyke-net fishery of Lake Erie.

States and counties.	No. of fishermen.	Fyke nets.		Boats.		Products.	
		No.	Value.	No.	Value.	Pounds.	Value.
Michigan:							
Monroe	17	65	$800	10	$225	87,000	$1,520
Ohio:							
Erie	118	915	58,850	117	13,570	2,100,150	32,948
Lucas	20	50	1,800	12	325	100,500	1,525
Ottawa	18	145	3,000	10	150	220,000	5,900
Total	173	1,175	64,450	149	14,270	2,507,650	41,893

The most important fish taken in fyke nets in this lake is the pike or pickerel, locally called the grass pike. It finds congenial quarters in the shoal, grassy bays and shores in the western part of the lake and is there taken in larger quantities than in any other lake. The next valuable products in their order are catfish, saugers, black bass, and yellow perch. A large amount of cheap, miscellaneous fish, consisting of suckers, sheepshead, rock-bass, etc., is secured, but need not be considered in this connection. Turtles are also taken in Erie County, Ohio.

The following table gives the quantity and value of the principal fishes taken in Lake Erie in 1890:

Products of the fyke-net fishery of Lake Erie.

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	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
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* Review of the Fisheries of the Great Lakes.

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All the fishing of the bay, with the exception of a little seining at the western end, is by means of fykes and small pound nets, which dot its shallow waters to the number of nine or ten hundred. Several seines are fished from the peninsula, both on the lake and the bay sides, and the fyke nets so numerous in the bay are also found in considerable numbers on the lake shore, though not used to any extent upon the islands. On the northern part of the peninsula, in the crotch between its two arms, are three marshy inlets with a total area of several thousand acres, which for about fifteen years have supported fyke-net fisheries of some importance. At present 107 nets are fished here by eight fishermen from the beginning of September to the 1st of May. The catch consists principally of bullheads and sunfish in fall, of bass in winter, and of grass pike in spring, with a large mixture of perch at all seasons. The fyke nets of the island region are mostly made of second-hand twine. The fyke proper, or pot, is 20 feet long, the hearts are 48 feet long, and the leaders, from 150 to 300 feet long. The size of the mesh is 4¼ inches in the leader, 4 inches in the hearts, and 2¼ inches in the pot.

LAKE ONTARIO.

In proportion to the extent of its general fisheries, there is no lake in which the fyke net is of greater importance than in Lake Ontario. An investigation* of the fisheries of this lake, conducted by the writer in 1891, disclosed the fact that the products of the entire industry in 1890 amounted to 3,446,448 pounds, valued at $124,786, while, as has been stated, the fyke-net catch alone was 899,527 pounds, having a value of $22,561; more than a fourth of the quantity and nearly a fifth of the value of the catch thus represented the output of the fykes.

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* Report on an Investigation of the Fisheries of Lake Ontario. Bull. U. S. Fish Commission, 1890.

As compared with 1880, the present status of the fyke-net fishery of this lake is more important than it was then; but since 1885 there has been a decrease in this fishery, as in the industry in general. An account* of the fisheries of this lake in 1885 stated that fyke nets had been employed for some years along various portions of the coast where the shore is low and swampy, or in bays where there are extensive mud flats, and were fished chiefly for bullheads, though small quantities of bass, yellow pike, eels, and perch were also secured. More than a thousand were said to be at that time fished with more or less regularity in the waters of the lake, most of them being owned by farmers living along the shore.

The extent of the fyke-net fishery decreases from east to west. In Jefferson County, which occupies the eastern part of the lake, more than two-thirds of the nets used in the entire lake are fished; and in Oswego County, which lies west of Jefferson, more than half the remaining nets are employed. The number of fishermen and the number and value of the fykes set in each county in 1890 were as follows:

Fyke-net fishery of Lake Ontario.

Counties.	No. of fishermen.	Fykes.		Boats.	
		No.	Value.	No.	Value.
Jefferson	42	458	$6,850	37	$1,582
Oswego	18	140	2,100	17	506
Cayuga	3	26	315	3	85
Wayne	6	39	365	4	80
Monroe	5	21	192	5	65
Total	74	684	9,822	66	2,318

Catfish enter most conspicuously into the catch and constitute nearly half the quantity and value of the yield. Next in point of value are pike, yellow perch, eels, and suckers, although the order of importance based on the quantity taken is perch, suckers, pike, and eels. The minor fish taken include sheepshead and rock bass. The fyke-net fishery of this lake in 1890 resulted as follows:

Products of the fyke-net fishery of Lake Ontario.

Species.	Pounds.	Value.
Bass	72,353	$1,845
Catfish	400,273	10,484
Eel	56,336	2,177
Perch	170,645	3,111
Pike	73,770	3,340
Suckers	76,820	1,056
Other fish	49,830	548
Total	899,527	22,561

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* Review of the Fisheries of the Great Lakes.

THE FYKE NET IN OTHER COUNTRIES.

Information is lacking on which to base a satisfactory account of the fyke-net fisheries of other countries. While it is known that the fyke net constitutes a more or less prominent type of apparatus in most of the principal waters of Europe and Asia, and doubtless other grand divisions, it is possible at this time to do little more than describe a few styles that have been met with in reports, museums, and expositions. While some of these are similar to and identical with nets employed in the United States, others represent widely divergent forms.

Aside from the general interest which a study of the different types of fykes possesses, descriptions of the fykes of other nations and illustrations of the forms peculiar to them may not be without practical value to our fishermen.

Fykes are used only to a limited extent in Canada. They are most numerous in the district of Montreal, in the St. Lawrence River, and in Lake Ontario. They are not found on the coast. The fishery is not very important and is mostly carried on by farmers whose lands abut on the waters in which the nets are set. The catch consists chiefly of sunfish, perch, catfish, and suckers, and other "soft fish" (*poissons mou*). Black bass are taken, but they are said not to remain in the nets when caught, and the yield is small. In Upper Canada the name "hoop net" is usually given to this form of apparatus; in lower Canada it is known as the fyke net. Among the French population it bears the same designation as in France—*verveux*. Its introduction into Canada can be traced to the early French colonists.

The fishery regulations operative in Canada requiring the issuance of a license for each device employed and limiting the number or quantity of apparatus that may be set by one person applies to fyke nets as well as to pound nets, trap nets, and other sedentary appliances, so called. The practice of setting fyke nets end to end, as is done in parts of the United States, is not permitted in Canada. Not more than one net may be set in a line, and the number that may be used by one person is limited to five. A license fee of $2 or $3 per net is charged.

The most common forms of fykes used in Canada have from 4 to 6 hoops, are usually provided with wings, and often have, also, a leader; they do not differ from similar nets used in the United States. One special type, however, seems to be peculiar; instead of opening into a regular pocket or bag, the last funnel enters and terminates in a large rectangular compartment like the bowl of a pound net or the crib of a floating trap. This style of fyke is employed only in the Richelieu River, which drains Lake Champlain.*

The fyke net is employed in a number of minor fisheries in Great Britain, where, as has already been stated, it is known as the hoop net. It is not a popular form of apparatus, and shares with the pound net and similar devices the disapprobation in which such sedentary fisheries are held in the British Isles.

An English writer on fishing nets, referring to this apparatus at a time when machine-made nets were unknown and unthought of, gives the following curious detailed instructions for its manufacture:

> The hoop net consists of two parts, the body and the valve or funnel, which are united in the manner hereafter to be described. Begin with the body at its lower or pointed end and work up to its mouth thus: Net 37 loops round on a 4-inch spool, one row; take a 2-inch spool and net 20 rows

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*For the foregoing information on the fyke nets of Canada the writer is indebted to Dr. William Wakeham, of the fisheries department of Canada.

of dead net; in the next row set in 5 false meshes equidistantly; then 20 rows of dead net; then a row with 5 false meshes; then 20 rows of dead net; then 5 false meshes in the next row; then 36 rows of dead net; net the thirty-seventh row in double twine. This done, cut off both threads, leaving ends, and fill a needle with single twine, but the last row you have netted being in double string, you have an upper and a lower row; to the end proceeding from this lower row, where the double thread was cut off and from which the valve is to issue, tie the twine you have on the needle and work as follows, taking care to pick up only the loops of the lower row on the needle as you go round: Net 14 rows of dead net, then, at equal distances in the circumference, make in the fifteenth row 8 stole meshes, *i. e.*, take 2 loops up at once 8 times in that row; then 2 rows of dead net; in the next row 8 stole meshes, and so on as before for 3 times more. After you have for the fifth time put in 8 stole meshes, net a row of plain netting; then lay aside your 2-inch spool and take a 12-inch, on which net 1 row. The funnel or valve is now finished and must be reflected inward to gain its right position. You now take your needle, charged with single twine, and join on to that other row which was left before and where the funnel issued from the body of the net. Net 11 rows of dead netting on your 2-inch spool; in the next row set in 5 false meshes, at equal distances from each other, and continue to set in 5 false meshes at every fourth row for 7 times, leaving 3 rows of dead netting between. After you have set in your false meshes for the seventh time, make 7 rows of dead netting, then one row on a 4-inch spool. This last row is strung on to a length of wood about 6 inches long and bent in a bow; a piece of stout string keeps the two extremities bent, answering to the string of an archer's bow, and the last meshes of the net's mouth are strung on to this string as well as on the bow. A moderate weight is generally attached to the bow at its extremities. Four hoops are placed round the net through the meshes of twenty-first, forty-second, sixty-third, and one hundredth rows (reckoning from the pointed end). The hoops are made larger as they proceed from the point toward the mouth, and all are made of much slighter wood than the bow. The diameter of the first or smallest hoop is about 1 foot 5 inches; the next about 1 foot 7 inches; the third about 1 foot 10 inches; and the fourth about 2 feet. The hoops are bound to the meshes by twine after they have been passed, and this, of course, is done before the ends of the hoops are lashed together. In some hoop nets more than one funnel is inserted, but many fisherman prefer only one.*

In the various parts of Germany a number of different forms of the fykes are used, and it appears to be a rather common means of fishing both on the coast and in the interior waters. Some of the nets closely resemble kinds used in the United States, which in all probability have been introduced by German emigrants, but most of the styles observed differ in some slight features from types employed in this country.

One common form consists of 8 iron hoops and 2 wings 6 feet in length; the first hoop is 16 inches in diameter, the last 6 inches, the hoops being from 10 to 18 inches apart. There are 3 funnels, which terminate in a square opening, from the corners of which lines pass to the adjacent hoops for the purpose of keeping the end of the funnel in proper position. The funnels are peculiar in that they do not originate from the hoops but several inches in advance of the hoops to which they would ordinarily be attached. The net described is such as is employed for eels. Similar nets, with 4 to 6 hoops made of iron or wood, are also used for both eels and fish. One style with 4 hoops, 2 funnels, and wings about 20 feet in length, employed in the vicinity of Memel, in East Prussia, on the Baltic Sea, is known as the *neunaugen reuse*, in allusion to the lampreys (*neunaugen*) taken. Another type, practically identical with this, but set for fish, is called a *fischsack*.

A double fyke, with wings and leader, such as is found in the Middle Atlantic States and shown in plate LXXX, fig. 1, is also used in parts of Prussia; each bag has 4 hoops and 2 funnels, the latter arising from the netting in front of the hoops, as already mentioned.

A very interesting fyke, analogous to an eelpot and probably set for eels, is found in northern Germany. It is known as a *bollreuse* (round fyke) and is peculiar in having 3 hoops of equal size and an opening at each end guarded by a funnel. In a model of this net, which has been seen by the writer and on which the figure (plate LXXXIX, fig. 2) is based, the hoops were 6 inches in diameter and were placed 6 inches apart in the bag; the funnels were 6 inches long and their ends were kept in position by lines passing from one to the other. The full diameter of the hoops is probably from 12 to 24 inches.

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* Notes on Nets. By Charles Bathurst. London, 1838.

A study of the fyke nets of Norway discloses the existence of a number of interesting forms operated in fresh and in salt water. The numerous fiords, coves, bays, and rivers and the generally irregular coast line which characterize that country would seem to favor the extensive use of fyke nets and contribute to the evolution of peculiarities in form and use depending on the different physical conditions prevailing and the various kinds of fishes taken.

One of the simplest and commonest types found in Norway is characterized by 4 hoops, 2 funnels proceeding from the first and third hoops, and 2 straight wings. An example of this style with unusually large hoops has been seen by the writer, the first hoop being 5½ feet in diameter, and the fourth 4 feet wide; the hoops consisted of rough, undressed saplings; the length of the net is about 20 feet. The wings are 25 feet long, are supported by two stakes, and join each other above and below about 2 feet in front of the first hoop, forming a kind of funnel-shaped entrance.

The setting of two simple nets at the ends of a common leader, which is an uncommon practice in the United States, appears to be frequent in Norway. One such arrangement has the following features: Length of nets, 9 feet; 3 iron hoops, 2½ feet in diameter; 2 funnels, from the first and second hoops, terminating in a circular orifice kept open by a wire ring; leader, 50 feet long, extending 1 foot into the first funnel of each net, supported by flat corks, 3 inches long, placed at intervals of 6 feet, weighted by earthenware sinkers 3 inches long and 6 feet apart. (See plate LXXXIX, fig. 1.) Similar nets with 5 wooden hoops (the first 2½ feet in diameter) and two funnels are also employed.

A single net at the end of a leader is also fished in some parts of this country. One form is 8 feet long and has 8 hoops, the first 20 inches in diameter, the last 8 inches; the first and second hoops are 20 inches apart, all others 10 inches; there are 4 funnels, arising from every alternate hoop; the leader is continued well into the first hoop. Larger nets of this type, with the first hoop 3½ feet wide, are also employed. On either side of the lower part of the first hoop rather heavy lead weights are placed in order to keep the net in an upright position. Such a fyke is usually set in salt water.

A curious Norwegian fyke, entirely unlike any that has been ascertained to exist in any other country, is illustrated in plate LXXXVII. The bag is 10 feet long and is supported on 7 arches made of stout, rough strips bent into the shape of a semicircle and fastened to broad wooden crosspieces. Funnels extend from the second and fourth arches. The first arch is 3½ feet wide at the base; the last bow is 6 inches high and 8 inches wide. A small anchor keeps the end of the net in place, and a strong rope runs the length of the fyke along the top and ends of each bow to add to the strength. Two 6-foot wings and a 10-foot leader are added, each supported at its distal end by a stake; they are buoyed by wooden blocks 10 inches long, about an inch wide, and half an inch thick.

Another form of net that appears to be peculiar to the Scandinavian peninsula is represented in plate LXXXVIII. The peculiarity is in the construction of the bag and the expansion of the final apartments. It consists of 7 hoops; the first is 2½ or 3 feet in diameter, and the others decrease in size until the fourth is reached, which is 6 or 8 inches wide; the fifth is the same size as the fourth and is separated from it by 2 inches of netting; the sixth and seventh hoops are about 10 and 12 inches wide, respectively. There are three funnels, which originate from the netting several inches from the first, second, and fifth hoops, as in the German fykes elsewhere mentioned. The entire net is about 8 feet long. Two wings 6 feet long, supported by stakes, diverge from the sides of the first hoop. The smaller end is anchored. In the language of the Norwegian fisherman, this net is designated *ruse til saltvands fisk* (fyke for salt-water fish).

In the rivers tributary to the Baltic Sea, the Gulf of Finland, and the Gulf of Bothnia, in Finland, fyke nets are used in large numbers. They are chiefly set for whitefish (*Coregonus oxyrhynchus*), herring (*Clupea harengus*), and salmon (*Salmo trutta*). The principal fisheries are in the rivers at the head of the Gulf of Bothnia. Some fykes with the first hoop 2½ or 3 fathoms in diameter are used in the Baltic Sea, Ladoga Lake, and Vuoksen River. A form which is most common in the latter stream has 4 to 7 hoops, each provided with a funnel; they are placed in sets of three or more on one side of a common leader, similar to the shad fyke used in Hudson County, N. J., with the funnels directed downstream, so as to intercept the fish migrating upstream. Another style of net which finds its prototype in the United States consists of two simple fykes set facing each other at the ends of a common leader; wings are sometimes added to this kind of net. It is generally set for small river fish. In the Gulf of Bothnia a net provided with curved wings and a leader extending to the shore is in use; it closely resembles some kinds of "pound" fykes in our waters. Another kind, with straight wings and a leader, is also in extensive use.*

A form of fyke which has been ascertained to be used only in Russia is represented in plate LXXXVI, fig. 2. A model which has been examined by the writer and on which the plate is based consists of a 4-foot bag of netting distended by 5 hoops of uniform size (2½ feet in diameter); the bag terminates at a circular block perforated with holes about half an inch wide, doubtless for the purpose of permitting the escape of small fishes that have been led into the net. The chief peculiarity of this fyke is in the funnels; these are two in number, extend between the first and second, and third and fourth hoops, and have rectangular orifices supported on a stout framework, as shown in the figure; the first opening is 2 inches wide and 16 inches high, the second is 2 inches wide and 8 inches high. The net is provided with a pair of short, straight wings. It is used in the River Don, and is known as the *vanda*.

The best account of the fyke nets of France which has been found is contained in a work published in Paris in 1769–1772.† This treatise has a very complete account of the different forms of nets employed in France and devotes considerable space to the particular kind of net under discussion. A large number of illustrations is given, some of which have been reproduced for this paper. So far as the information at hand goes, the French fishermen seem to have a greater variety of fyke nets than exists in any other country of Europe.

Two general types of nets, recognized in France by different names, appear to belong to the general class of fykes: these are the *guideaux* and *verveux* or *verviers*, so called. The former are very long cylindrical-shaped bags, distended with one or more hoops; the simplest *guideaux* seem to lack a funnel, and therefore not to be true fykes, the escape of the fish being prevented by the folds of the long, tapering sack. The *verveux* differ from the *guideaux* in being shorter and in always having one or more funnels. As defined in the work referred to, the *verveux* are like the *guideaux*, but "in order to prevent the fish from escaping one adds at the entrance and inside a net large in the mouth and terminating in a point, called the *goulet*." Besides the synonym *verviers* already given, a number of other names are applied to fykes in different parts of the country, among which are *loup* (wolf), *renard* (fox), and *quinque portes*, the latter designation being for an arrangement of five fykes such as is figured in plate LXXXIV, fig. 4. Fykes used on parts of the seacoast are variously called *queues*, *manches*, *sacs*, and *caches*.

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* For these notes on the fyke nets of Finland acknowledgments are due to Dr. Oscar Nordqvist, government inspector of fisheries in Finland.

† Traité Général des Pesches, et Histoire des Poissons. Par M. Duhamel du Monceau. 5 vols.

Of the many kinds of fyke nets used in France and the various methods of setting them it is necessary to refer to only a few that present especially striking features. Some of these are figured in plates LXXXIV, LXXXV, and LXXXVI, fig. 1.

Simple nets, with numerous hoops and without leader or wings, are common. The entrance is usually arched. Some are set singly and others are placed close together side by side, so as to more completely cover a stream or section of coast. Three nets of this class are illustrated. In one the fish are finally led into a wicker compartment similar to that seen in oriental fishing devices.

A curious cylindrical net formed on three hoops of uniform size and having an entrance at each end consisting of a long funnel extending obliquely toward the top of one hoop and toward the bottom of the other is figured in plate LXXXIV, fig. 2. Poles are attached along four sides for the purpose of strengthening the net and to afford support to the buoy, weights, and ropes required in setting and hauling the net.

Methods of setting fyke nets with wings and three ways of constructing the wings are shown in plate LXXXV. The wings are termed *haies*, *arrets*, *brayes*, or *tonnelles*, according to the locality. Such nets are usually placed in localities in which the tide goes out rapidly and leaves them bare or nearly exposed, as at the mouths of small streams or bays. The net is pointed towards the water at right angles to the shore. These nets, besides the manner shown in the plates, are sometimes set in zigzag series, so that they will take fish swimming in either direction, each single wing being a part of two nets which face in opposite directions.

Nets provided with wings are also in use in parts of France. Those found in print consist of 5 to 7 hoops, with as many funnels. The wings are corked and weighted and tied to large stones at their ends. The net is kept in position by being attached to a large stone and by having individual weights tied to the sides of each hoop.

The method of combining a fyke net with the leader and heart of a pound net, as is done in the United States, is exhibited in plate LXXXVI, fig. 1.

At a comparatively early period in France the fyke net seems to have received its due share of legislative attention and to have caused in some localities a marked diminution in the supply of fish ascending streams. Referring to the type of net figured in plate LXXXIV, fig. 4, it is stated that—

> Following the ordinance, an interval of 15 *brasses* should be left between each net. The fishermen arrange the nets so that what escapes one set of nets is caught by the other; or, altogether contrary to law, they set them close together, and in placing enough to occupy a great part of the river in this manner they catch all the little fishes which are swimming upstream and were destined to people the river with big fishes. The fishermen, who can not get any good out of these, throw them on the bank, where they infect the air; and the result is that fisheries which twenty years ago were worth a thousand livres are now worth not more than 200 livres, and the fishermen are ruined.—(**Traité Général des Pesches, et Histoire des Poissons. 1769–1772.**)

The fyke is not absent from the waters of Southern Europe. The fishermen of the Adriatic Sea employ a number of forms of this net, which is in some instances combined with seines and trawls.

The form of net called the *cogolo* seems to correspond very closely with the simpler fykes in this country and is the essential feature of the more elaborate nets. The *cogolo* is described* as a hempen net made in the shape of a long conical bag, narrowing by degrees to the tail end, and held open by successive hoops (*cerchietti*). It is composed of different parts: the first, called *chiara*, is large-meshed; the second is the *busto*, and is made of smaller meshes; the third is the *mezzana*, made of still smaller meshes; last comes the *pillela* or *piela*, the purse, made of very coarse and strong twine and very small-meshed, into which the fish enter through a kind of very narrow funnel called *enoa*. Once inside, they become packed, and are unable to turn back. It is also used for catching eels in the fishing ponds (*valli chiuse*).

A form of apparatus consisting of a seine combined with a *cogolo* is known as *bragagna* among the Adriatic fishermen and is fished from a boat called *braganella*. The boat, having previously cast anchor at a short distance off, hauls in the anchor chain on a roller (*molinello*), thus drawing the net in its wake. The net has no floats to keep up the head, but is held stretched in the water by a series of sticks fixed vertically along the two wings and around the mouth of the bag. At the end of each of the wings there is a small *cogolo* with three hoops, with the opening in an opposite direction to that of the middle bag. It is well weighted at the foot (*ima*) to keep it down, and the drag-rope ends are attached to the bows and the poop, the boat moving broadside on (*in fianco*), the net grazing the ground; it is worked by day or night, on muddy beds, in shallow water, in creeks and lagoons, chiefly for gobies and small shore fish. Length, 20 m.; depth, 4 m.; mesh, 2½ cm.; price, 60 florins.

Another net in which the fyke principle is an essential feature is operated in the Adriatic Sea. It is known as the *cocchia* or *coccia*, and is used exclusively by the *Chioggiotti*. It is drawn by two boats (*brogazzi*) under sail, each boat running parallel to the other and drawing one end of the net, which is held by drag ropes (*alzana*) 40 to 50 fathoms in length. It is worked, by preference, against the current, over muddy grounds by day, the mud raised by the passage of the net clouding the water and shutting out the light, which renders the fish confused and motionless, whereby they become an easy prey. At night it is worked over rocky beds. The depth of water in which operated varies from 20 to 50 fathoms.

The structure of this net differs from that of the seine (*tratta*) in the shape of the bag (*sacco* or *panza*), which in this case is conical, measuring 5 to 6 fathoms across at the opening and narrowing by degrees to 8 to 10 feet in diameter. Here commences a kind of funnel, which is kept open by means of hoops and ends in a purse, the opening of which measures 5 feet across, and the ends of which are gathered and secured by a rope. This has simply to be undone when the net is hauled on deck and the fish fall out at the end. The funnel and purse are known as the *cogolo* and form about one-half of the total depth of the bag, which is 6 fathoms. The *cogolo* is generally inclosed in a second net of coarse string in order to protect it against the friction with the bed and the depredations of the dolphins, which are apt at times to injure the net. The length of the wings or arms is often as much as 30 fathoms each, the depth being 10 feet at the ends and 20 feet towards the middle, where the bag commences. The bag is small-meshed (1½ to 2 centimeters) and well corked at the head to keep it well open whilst in motion. It is also extra weighted at the foot, so that it falls quickly to the bottom and is thus trawled along the ground, the boats being under full sail, the faster the better, the Italian fishermen fishing in almost all kinds of weather. Two pieces of wood are fastened longitudinally to the under side of the bag to protect it from friction with the ground and to enable it to slide along with greater facility. The value of the *cocchia* is about 100 florins. This mode of fishing was prohibited by the Venetian Republic in former times and by the Austrian Government by the enactment of 1835; but the want of organized inspection rendered it impossible to enforce the prohibition, and it is once more recognized under the Austro-Hungarian and Italian treaties of commerce of 1867 and 1878.*

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*The Fisheries of the Adriatic. By G. L. Faber. London, 1883.

A stationary form of fyke net is used in the Venetian lagoons and the head waters of the Adriatic Sea. The fish are led into the fykes (*cogoli*) by means of converging screens or hedges (*serragli*) constructed of netting or reeds. As the tide recedes, the fish which may be inclosed within the hedges find their way into the *cogoli*, which are drawn up by means of a float to which they are attached, and are emptied of their contents.

In Spain and Portugal some of the fykes resemble the nets of northern Europe; some are similar to those of Italy and Austria; and some appear to be more or less peculiar to this part of Europe. Representations of some nets used in Portugal are shown in plates LXXXIX and XC, the illustrations being copied from a report† on the fisheries of that country.

The typical fyke is known in Portugal as the *botirão*, which is described in the work referred to as a "trap (*armadilha*) made of bows and netting, with a pyramidal or prismatic form, having a funnel-shaped opening through which the fish enter." The forms recognized are the movable or set fyke (*botirão de deitar*), the hand fyke (*botirão de mão*), and the stationary fyke (*botirão fixo*). One of the most extensively used is the first named, shown in plate LXXXIX, fig. 4. It has an arched entrance and 4 hoops, the second of which is largest, a short funnel arising from the second hoop. Connected with either side of the arch and extending backward along the hoops is a pole, which enters the cavity of the net at the third hoop, proceeds through the end of the final compartment, joins its fellow, and is finally fastened at a stake driven into the bottom a short distance from the net. A heavy stone is placed in the arched entrance and another is tied to the united side poles beyond the end of the net. From the top of the last hoop a piece of bait is suspended within the net. Two other forms of fykes, with only a single hoop, are represented in plate XC. One has a square entrance, supported by stakes, occupying the anterior third of the length of the net, the hoop, funnel, and bag constituting the remaining part. The other style has a leader, somewhat longer than the net proper, proceeding from the shore, the entire net being weighted and buoyed.

Another form of Portuguese fyke, having the general appearance of a pot, is shown in plate LXXXIX, fig. 3. It is called a *muzuar*, and consists of four broad bands of metal supporting a short bag; there is one funnel, and the end of the net is closed by a round door on a hinge, as is well exhibited in the figure. This net is employed principally in the capture of lampreys.

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* The Fisheries of the Adriatic.

† Estado Actual das Pescas em Portugal. Por A. A. Baldaque da Silva. Lisboa, 1892.

The ingenuity of the oriental mind has produced a marvelous variety of fishing apparatus; especially in China and Japan is there a bewildering multiplication of forms of nets, among which the fyke is well represented, either as a simple type or in combination with other kinds of apparatus. Bamboo is the material from which a great many nets, especially the more primitive ones, are constructed, but twine is also in common use in most localities. The absence of printed information in the English tongue precludes more than the mere mention of a few facts on this subject that have been incidentally collected.

A form of beam trawl employed in Japan for the capture of lobsters has, for the most essential part, a simple fyke net. The entire trawl is about 30 feet long, of which the fyke proper constitutes somewhat less than half. The mouth of the trawl, which is about 10 feet wide, opens into a compartment formed by netting above and on the sides and by the bottom of the sea below; the upper edge of this inclosure is buoyed by corks or wooden floats; and the sides are kept on the bottom by means of weights. The compartment tapers until it becomes 5 or 6 feet wide, when it joins the hoop of a fyke net. The fyke consists of a single hoop, a funnel, and a bag which tapers to a rather sharp point. The hoop is iron below, a break in its continuity being supplied by a large weight retained by a rope. The funnel terminates in a square aperture, kept open by lines running to the bag.

Figures of three forms of Chinese fykes are given (plate XCI). These are selected from a large number of illustrations to show the different applications made of the fyke principle. The simplest form has already been referred to (page 303). It consists of a bag-shaped net distended by one hoop and provided with a single funnel (fig. 1). The combination of three such simple nets, with the addition of certain accessory parts, constituting a kind of fyke entirely peculiar to this country, is represented in fig. 2. This is called by the Chinese *san-yen-kao*. It is described as follows:

> The *san-yen-kao* is composed of 3 fyke nets, having an opening of 3 feet in diameter and a length from 4 to 5 feet; there are iron weights holding the ends of these pockets, which open into a thread net with rather large meshes. This latter is held up by two stakes from 5 to 10 feet in diameter and 4 to 5 inches in thickness, which are driven into the ground at a distance of 12 to 14 feet from each other. On these two supports and above the thread net is fixed a plank 3 feet wide, covered with a white varnish and half submerged in the water. On the sides of this apparatus are two trellised inclosures in bamboo, which are used to prevent the fishes from escaping at the sides. The *san-yen-kao* is placed in rivers or in lakes, in pairs not far from each other, and is visited several times each day.—(La Pisciculture et la Pêche en Chine. Par P. Darby de Thiersant. Paris, 1872.)

An example of a style of fyke used in falls, in swift currents, or at the mouths of lagoons or rivers left partly dry by the tide, appears in fig. 3. The bag is long, narrow, and fusiform, and has a small entrance guarded by a funnel. Wings of various shapes and materials are provided, and serve to direct the current of water and with it the fish. The bag is kept distended by the force of the current. The particular style figured is known as a *tcha-kao*, and is placed at the mouths of lagoons and lakes.

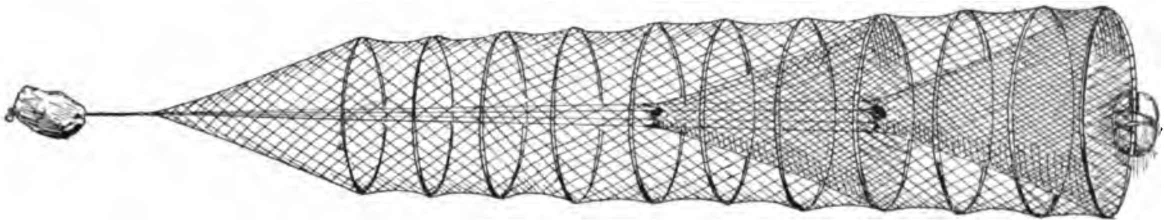


Fig. 1. BROOK FYKE; DROP FYKE. DELAWARE RIVER.

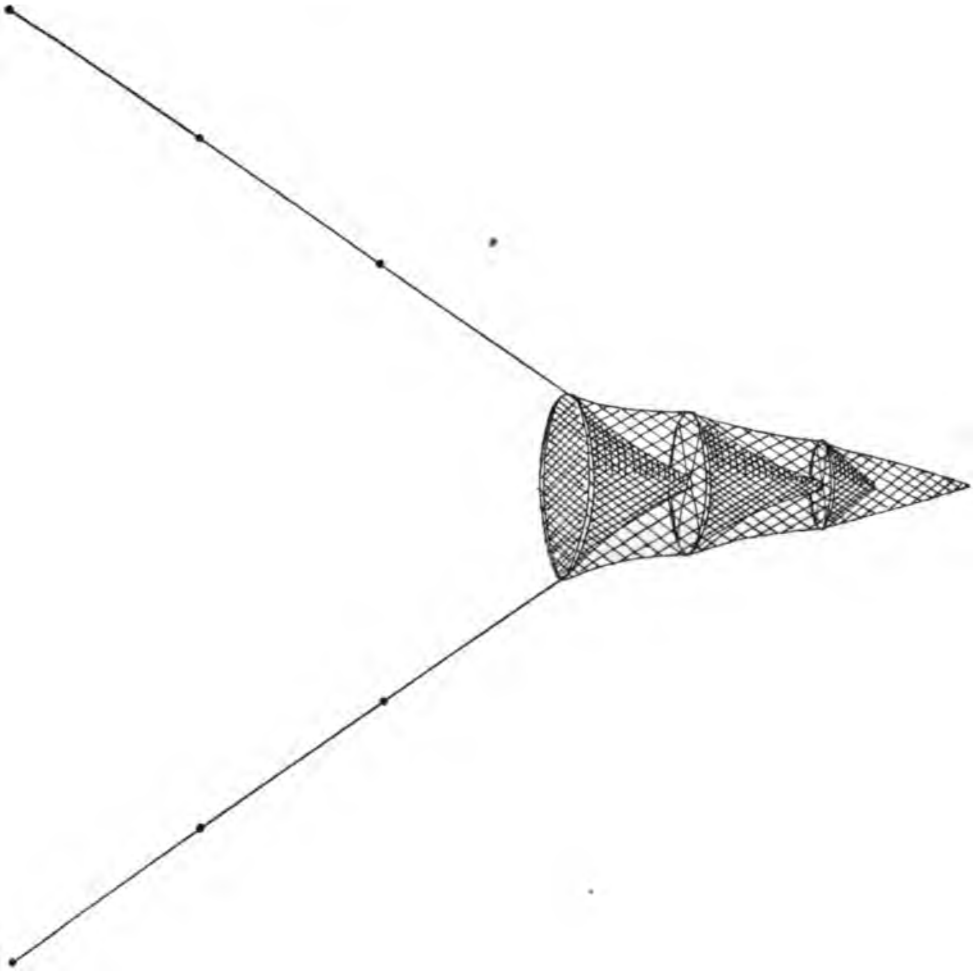


Fig. 2. TERRAPIN FYKE; "BUCKDART." MARYLAND.

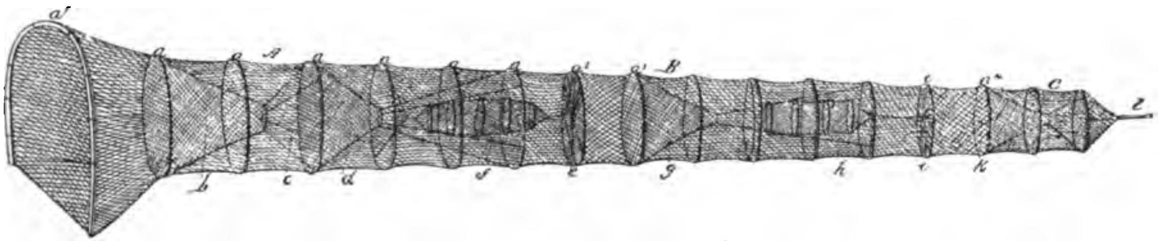


Fig. 3. "FISH NET." PATENTED IN 1844.

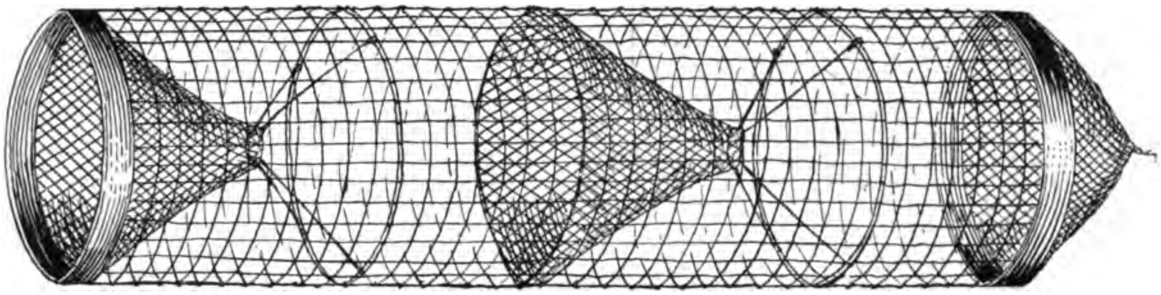


Fig. 1. EEL FYKE; EEL BAIT-POT. EASTERN UNITED STATES.

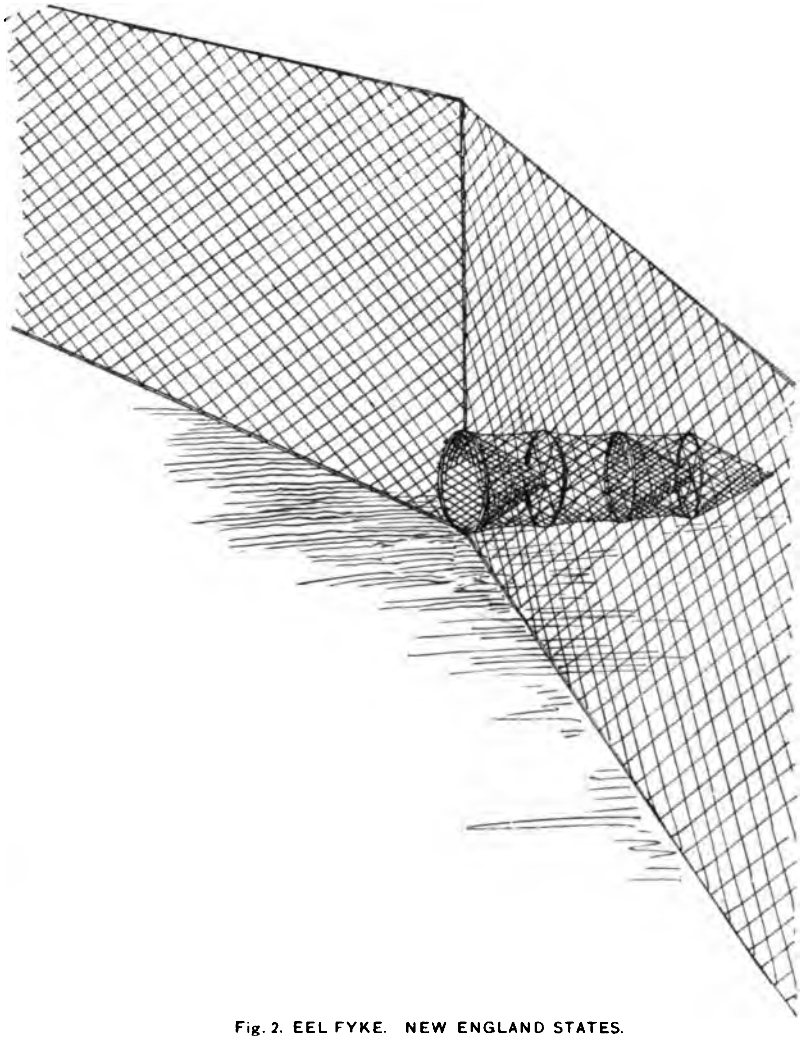


Fig. 2. EEL FYKE. NEW ENGLAND STATES.

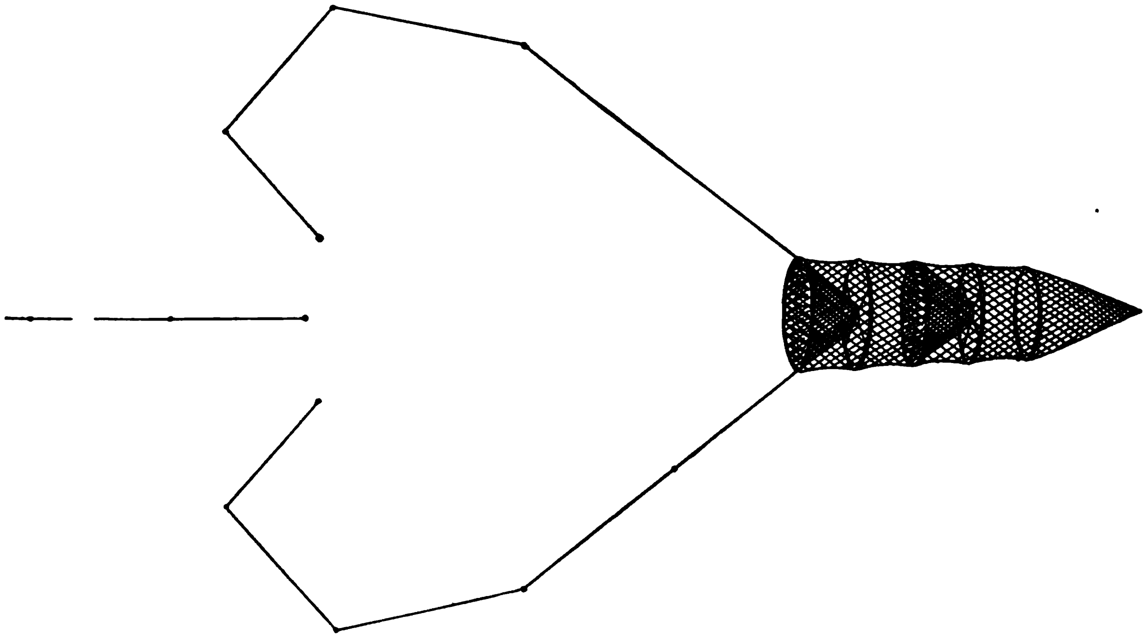


Fig. 1. POUND FYKE, WITH ANGULAR WINGS. MIDDLE ATLANTIC STATES.

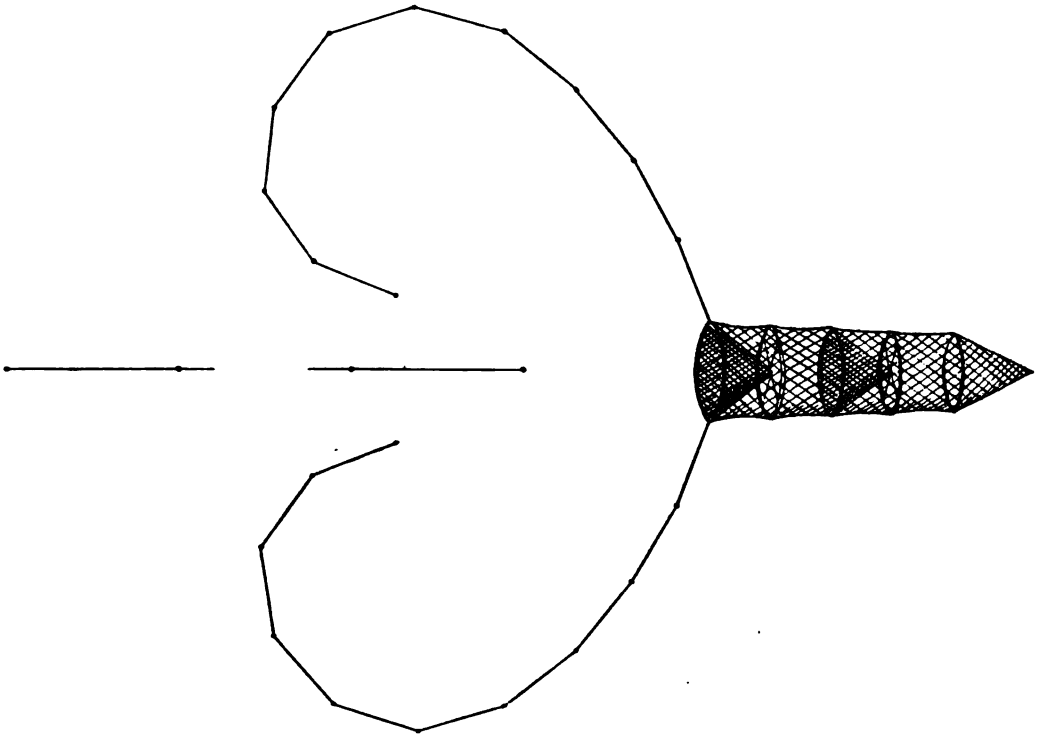


Fig. 2. POUND FYKE, WITH CURVED WINGS. MARYLAND.

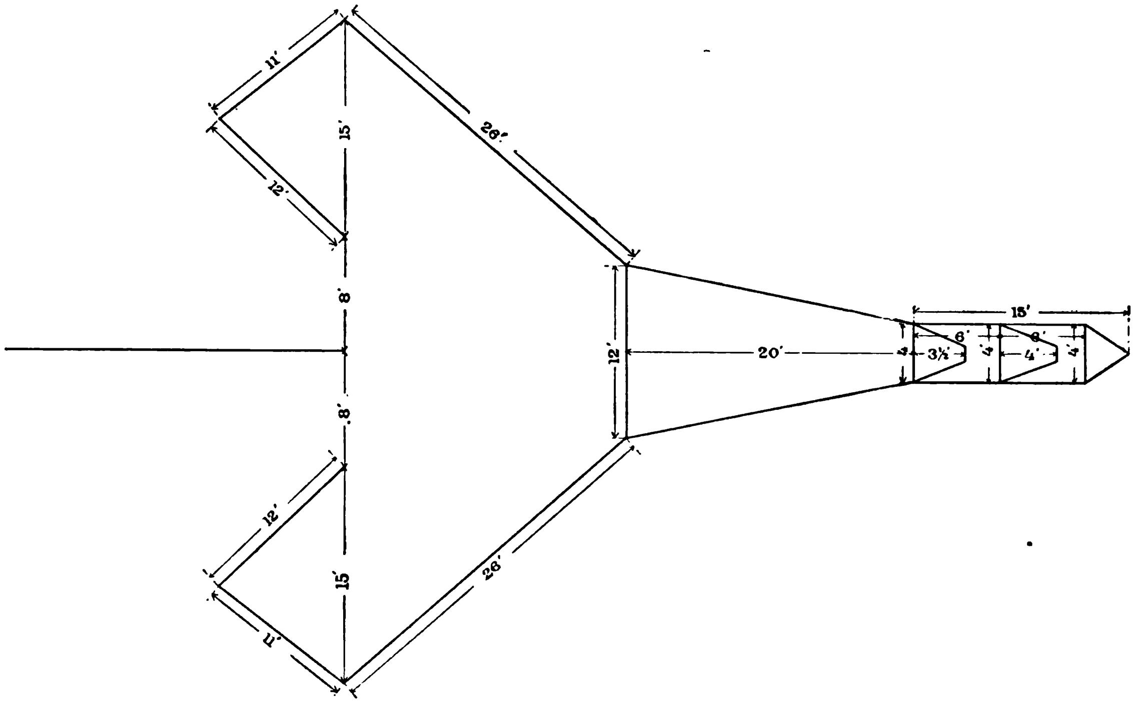


Fig. 1. POUND FYKE—PLAN. GREAT LAKES.

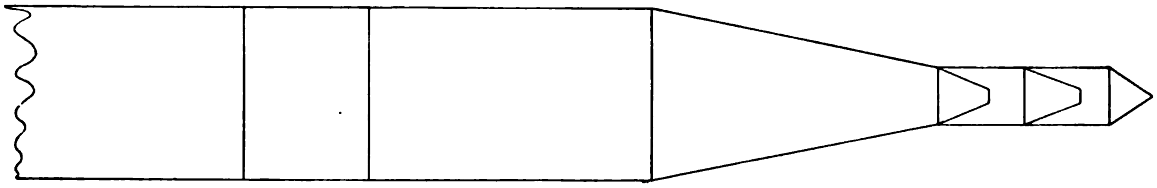


Fig. 2. POUND FYKE—SIDE VIEW. GREAT LAKES.

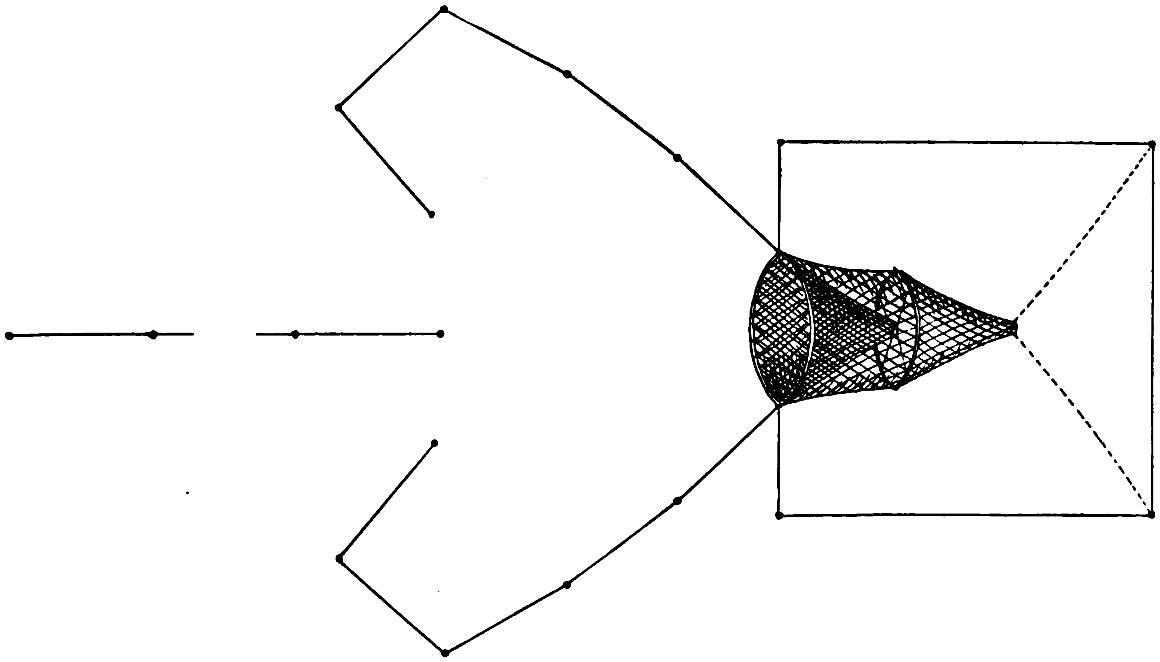
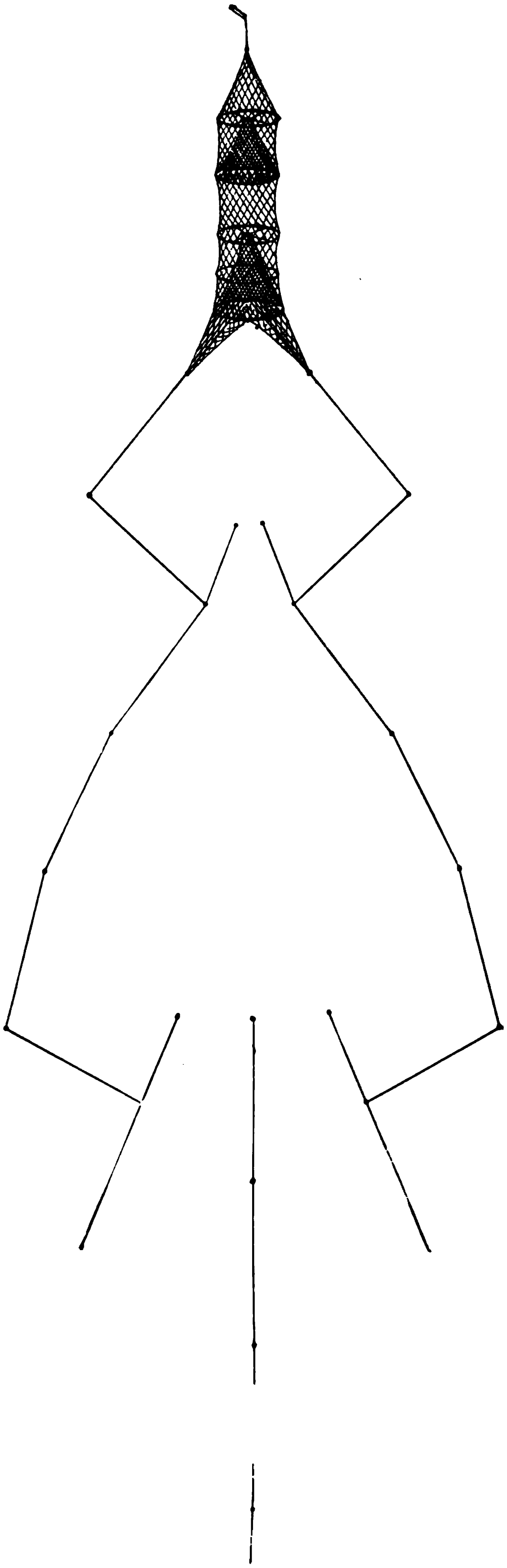


Fig. 3. "FUNNEL-MOUTH POUND." VIRGINIA.



POUND FYKE. MONMOUTH COUNTY, NEW JERSEY.

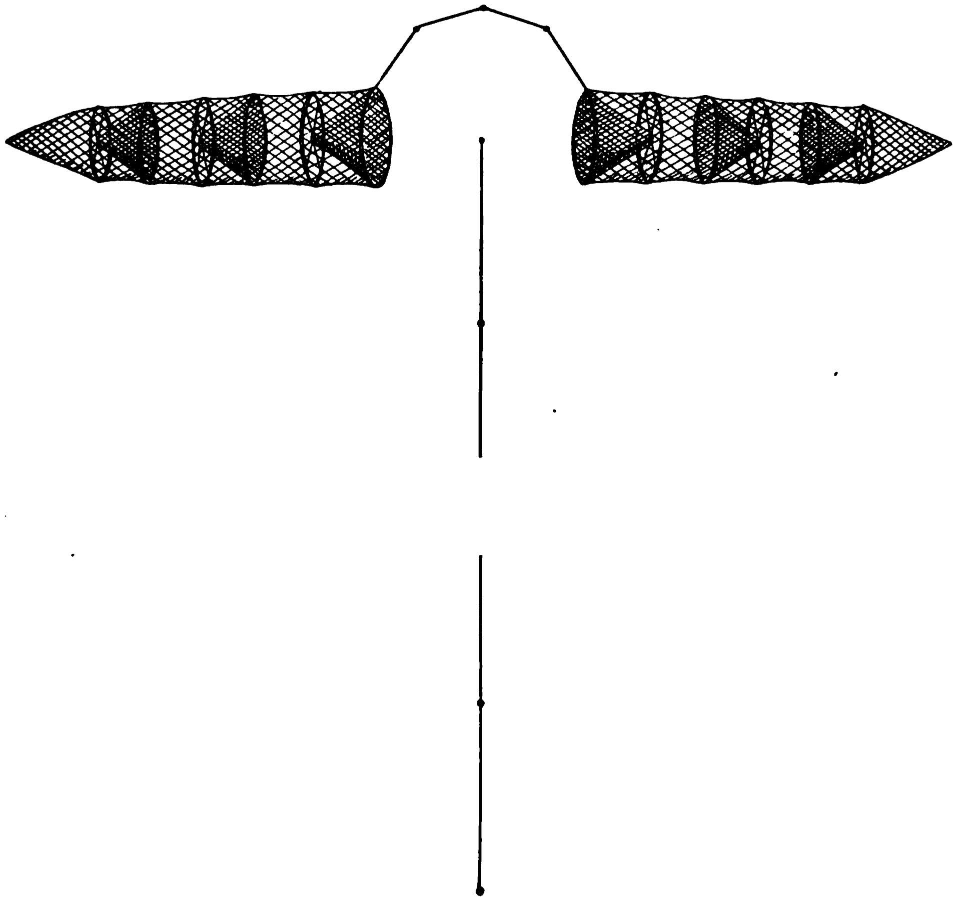


Fig. 1. DOUBLE FYKE; "SET OF FYKES." MARYLAND.

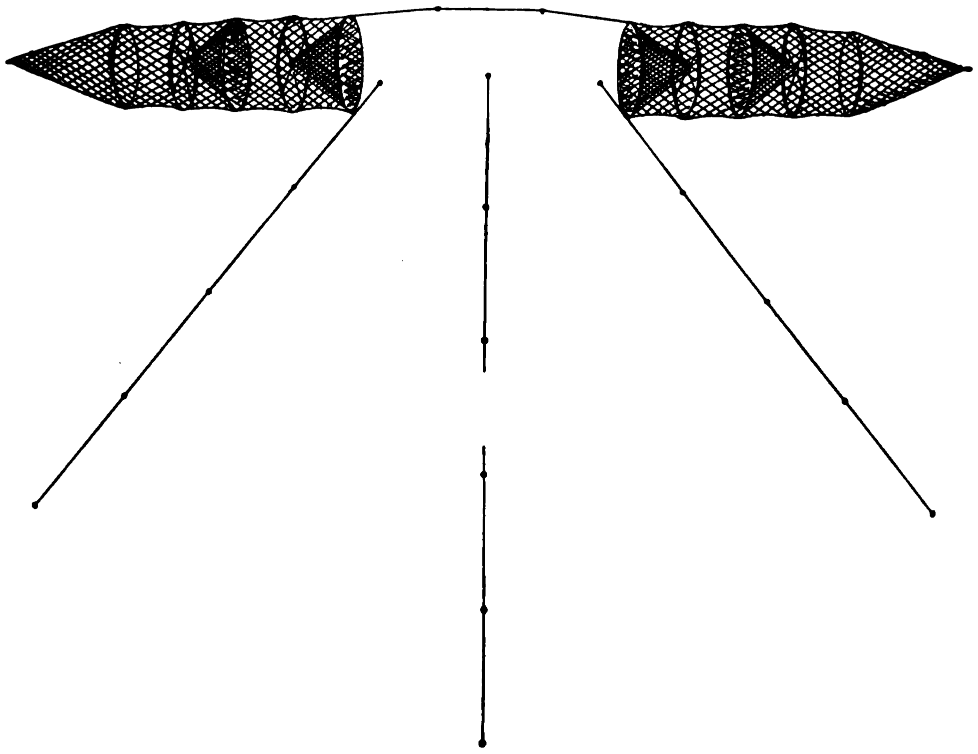


Fig. 2. DOUBLE FYKE; "SET OF FYKES." MARYLAND.

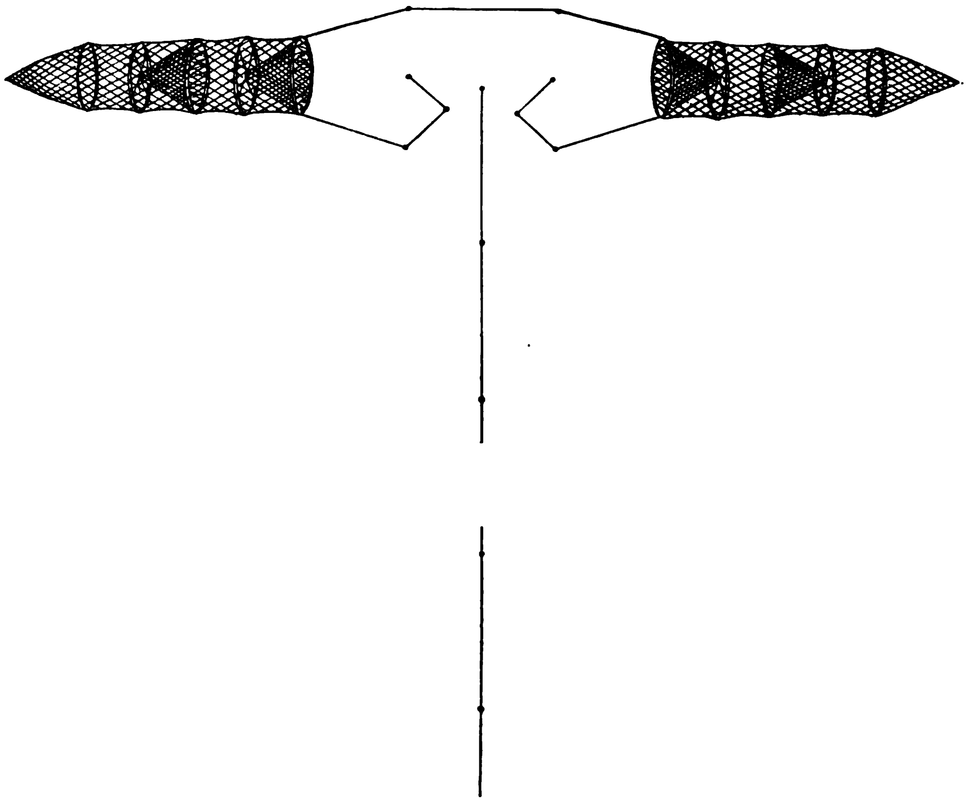


Fig. 1. DOUBLE FYKE; "SHAD FYKE." NEW JERSEY.

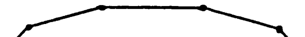


Fig. 2. DOUBLE FYKE, WITH SQUARE ENTRANCE; "HEDGING FYKE." BALTIMORE COUNTY, MARYLAND.

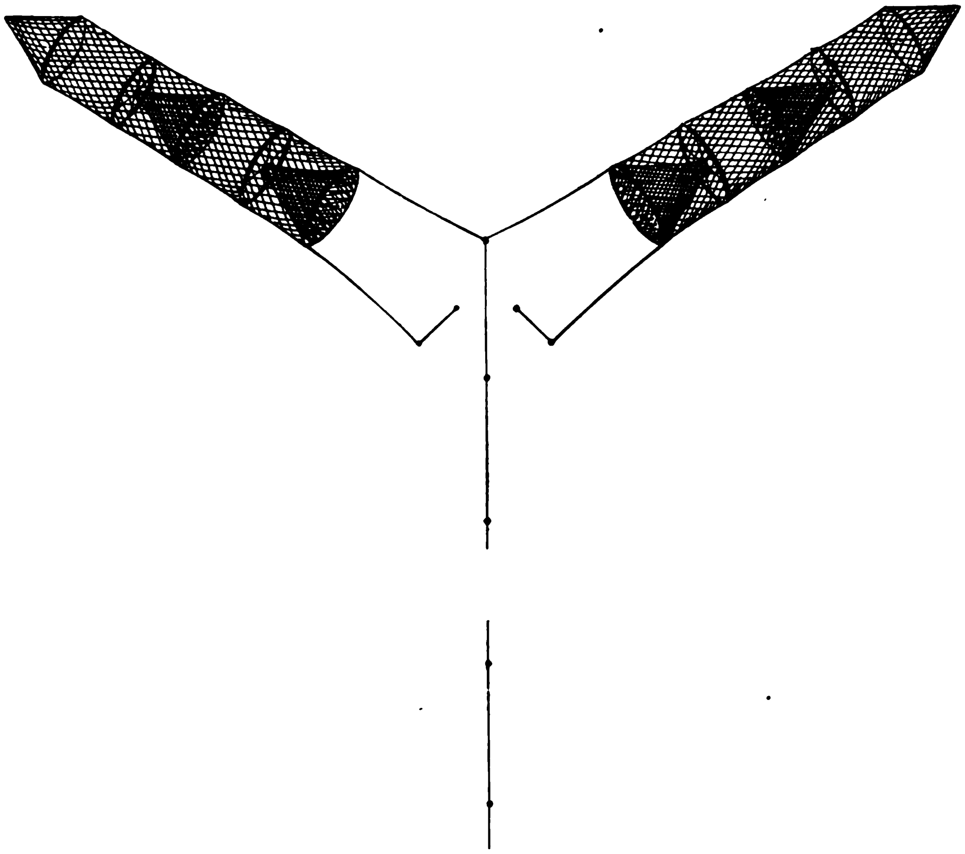


Fig. 1. DOUBLE FYKE; "BASS FYKE." NEW JERSEY.

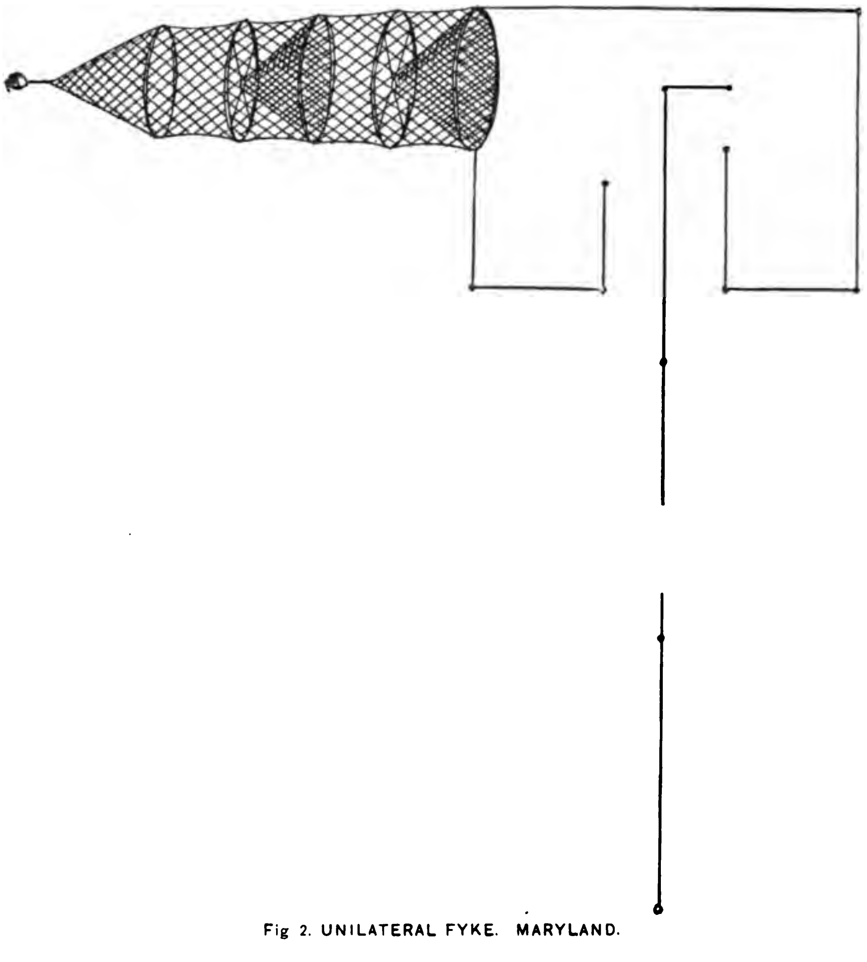
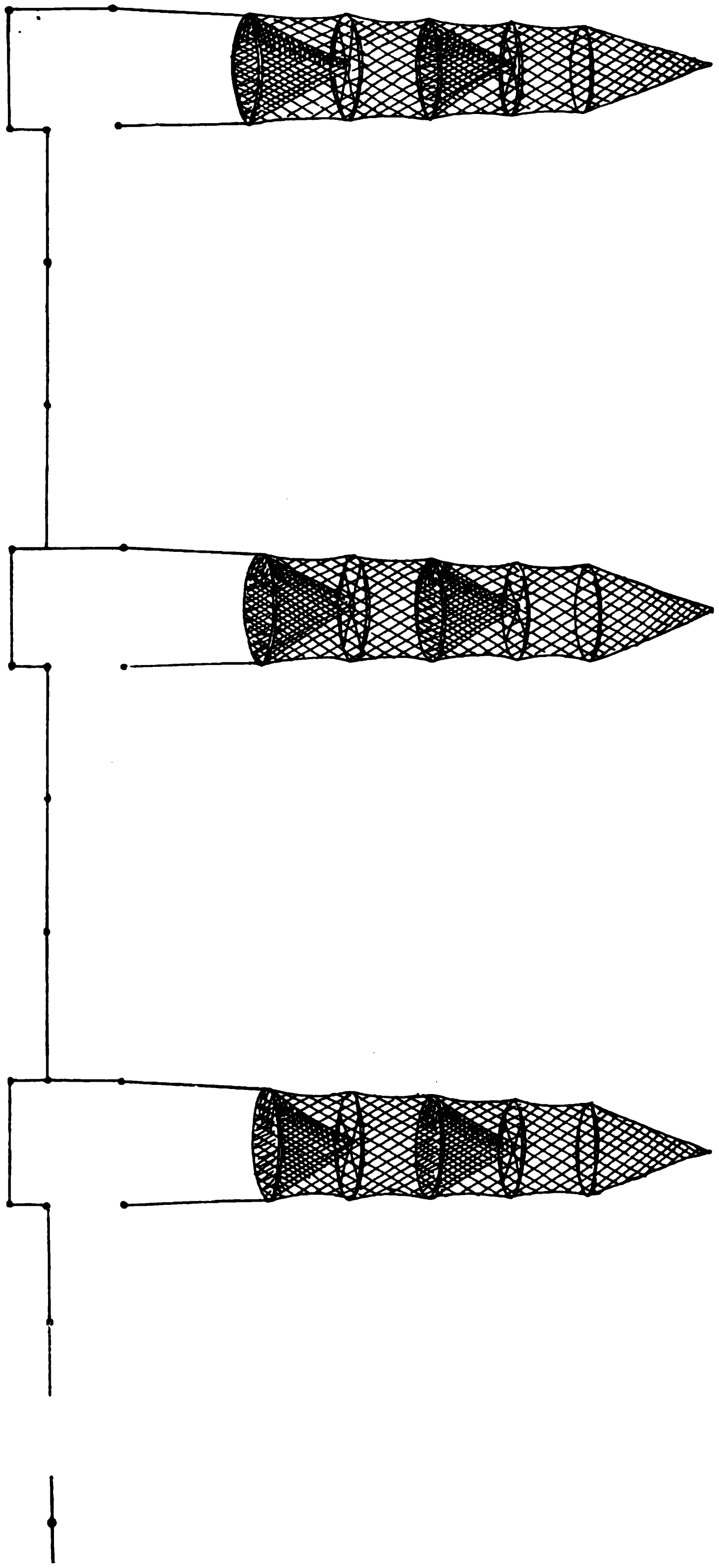


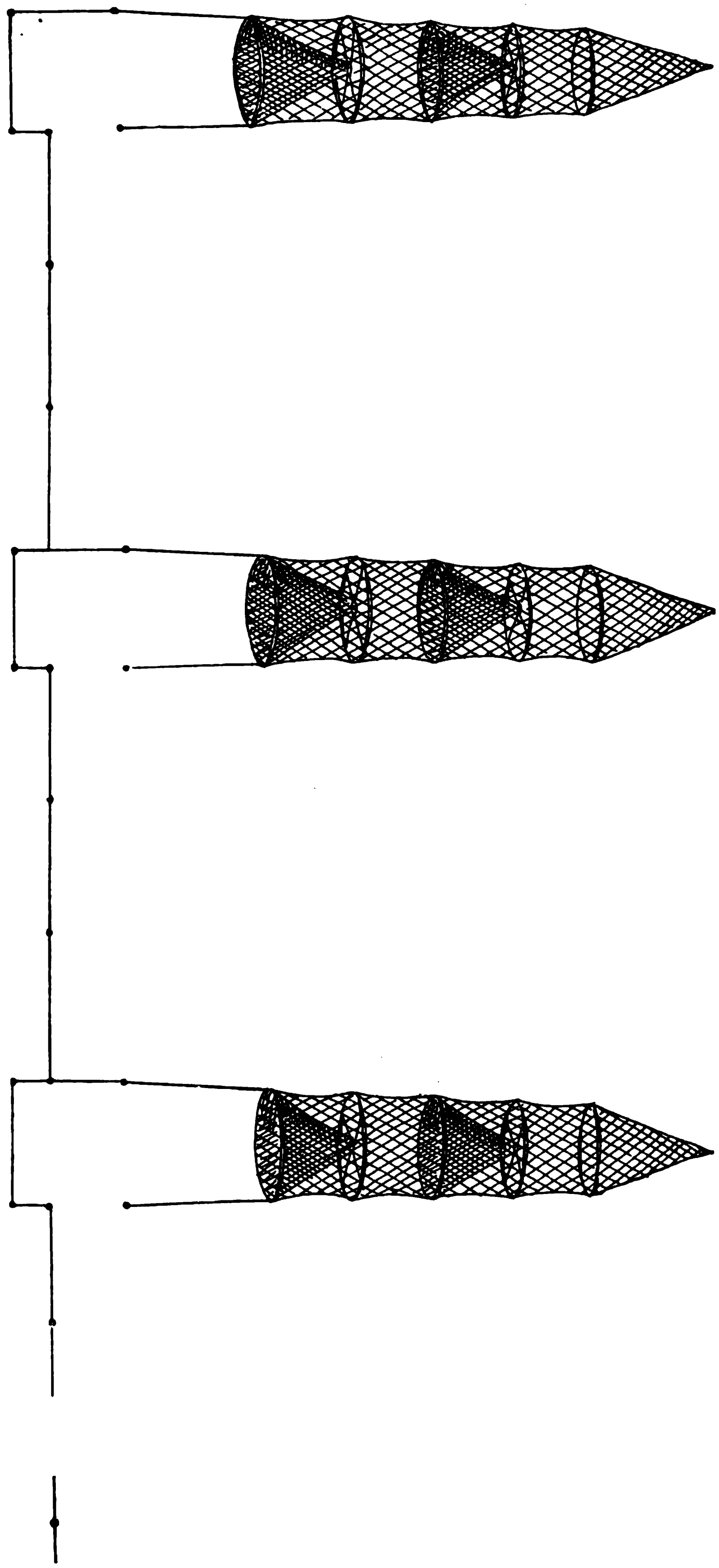
Fig 2. UNILATERAL FYKE. MARYLAND.

PLATE LXXXIII.



METHOD OF SETTING UNILATERAL FYKES FOR SHAD. HUDSON COUNTY, NEW JERSEY.

PLATE LXXXIII.



METHOD OF SETTING UNILATERAL FYKES FOR SHAD. HUDSON COUNTY, NEW JERSEY.

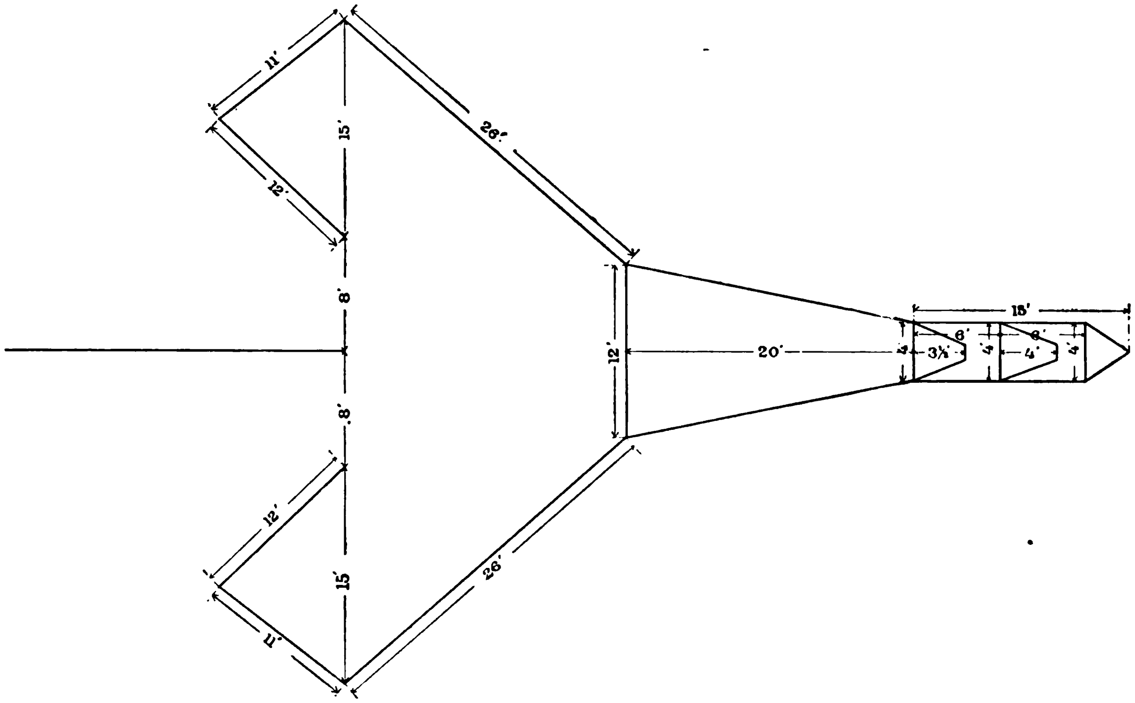


Fig. 1. POUND FYKE—PLAN. GREAT LAKES.

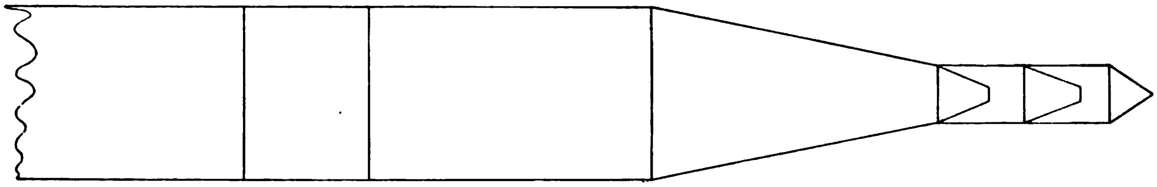


Fig. 2. POUND FYKE—SIDE VIEW. GREAT LAKES.

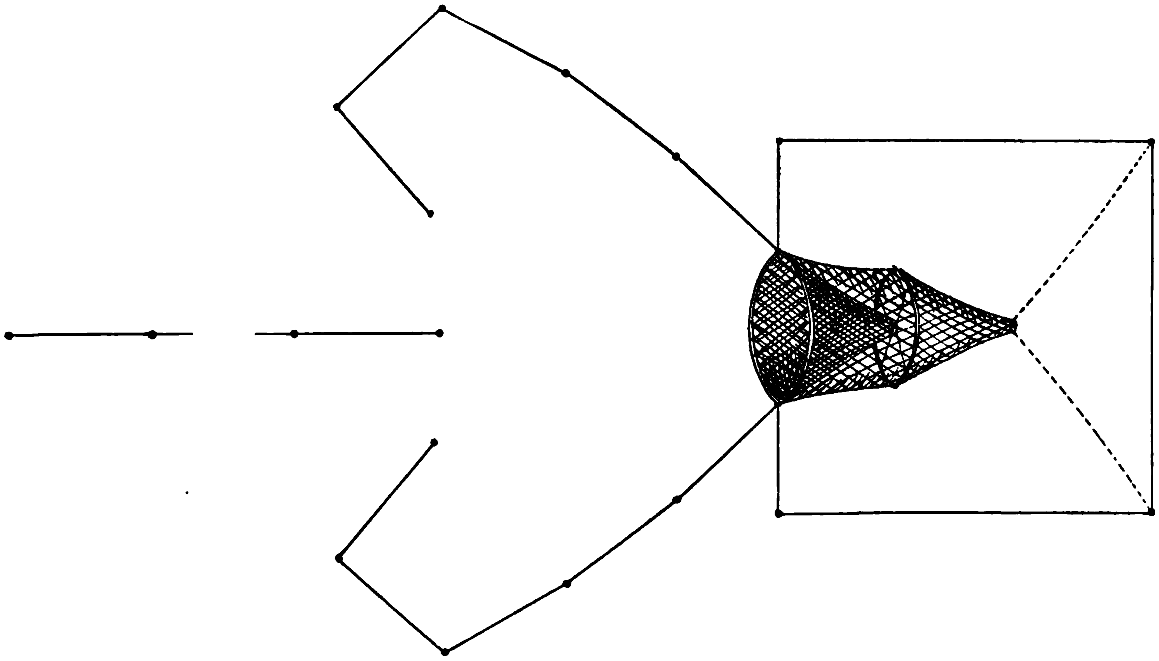
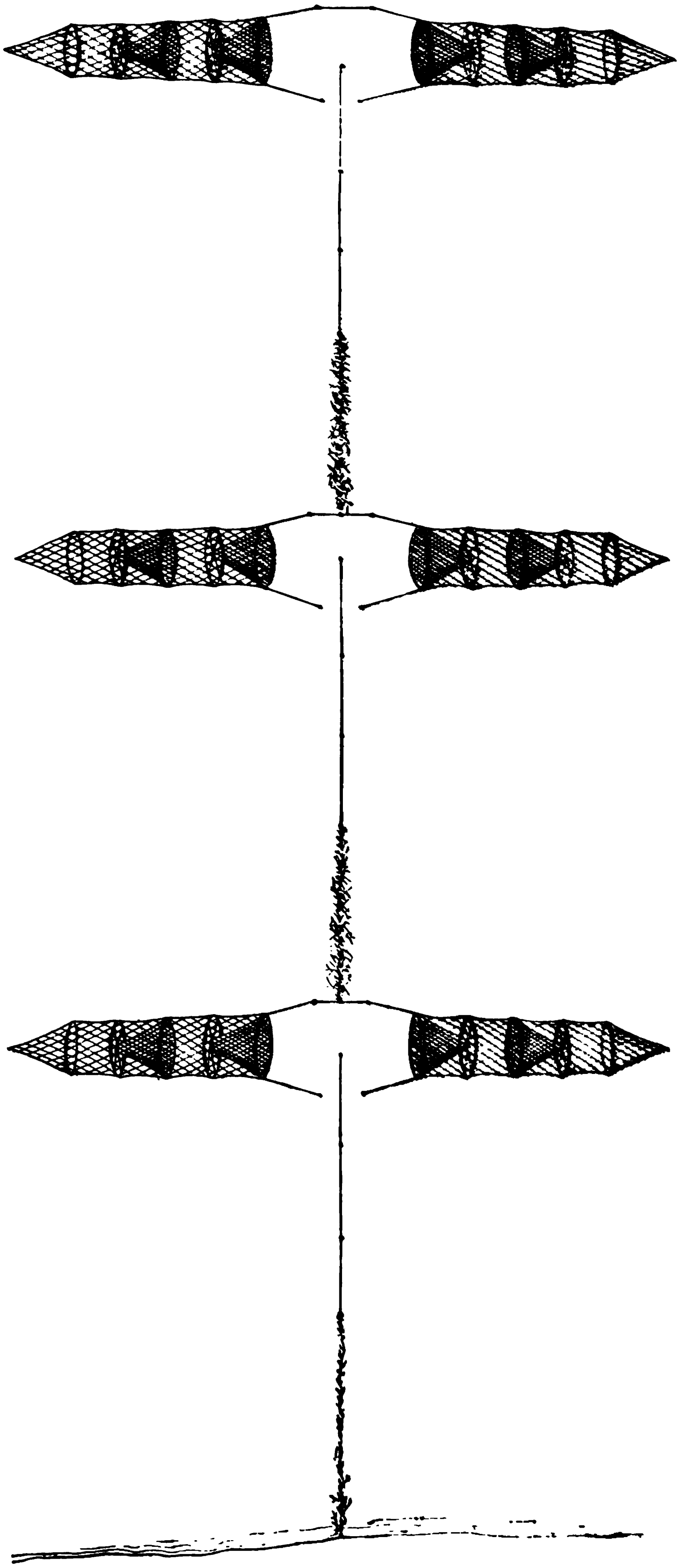
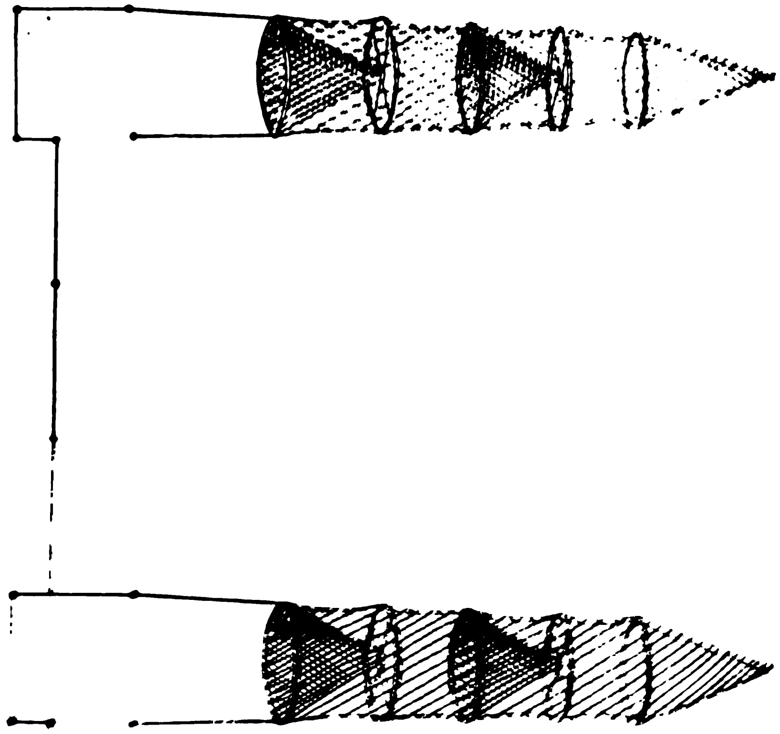
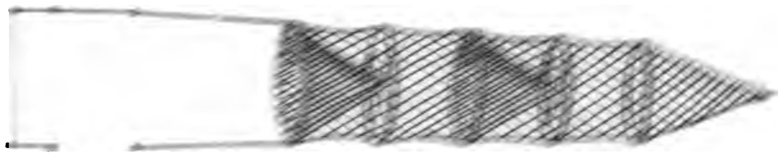


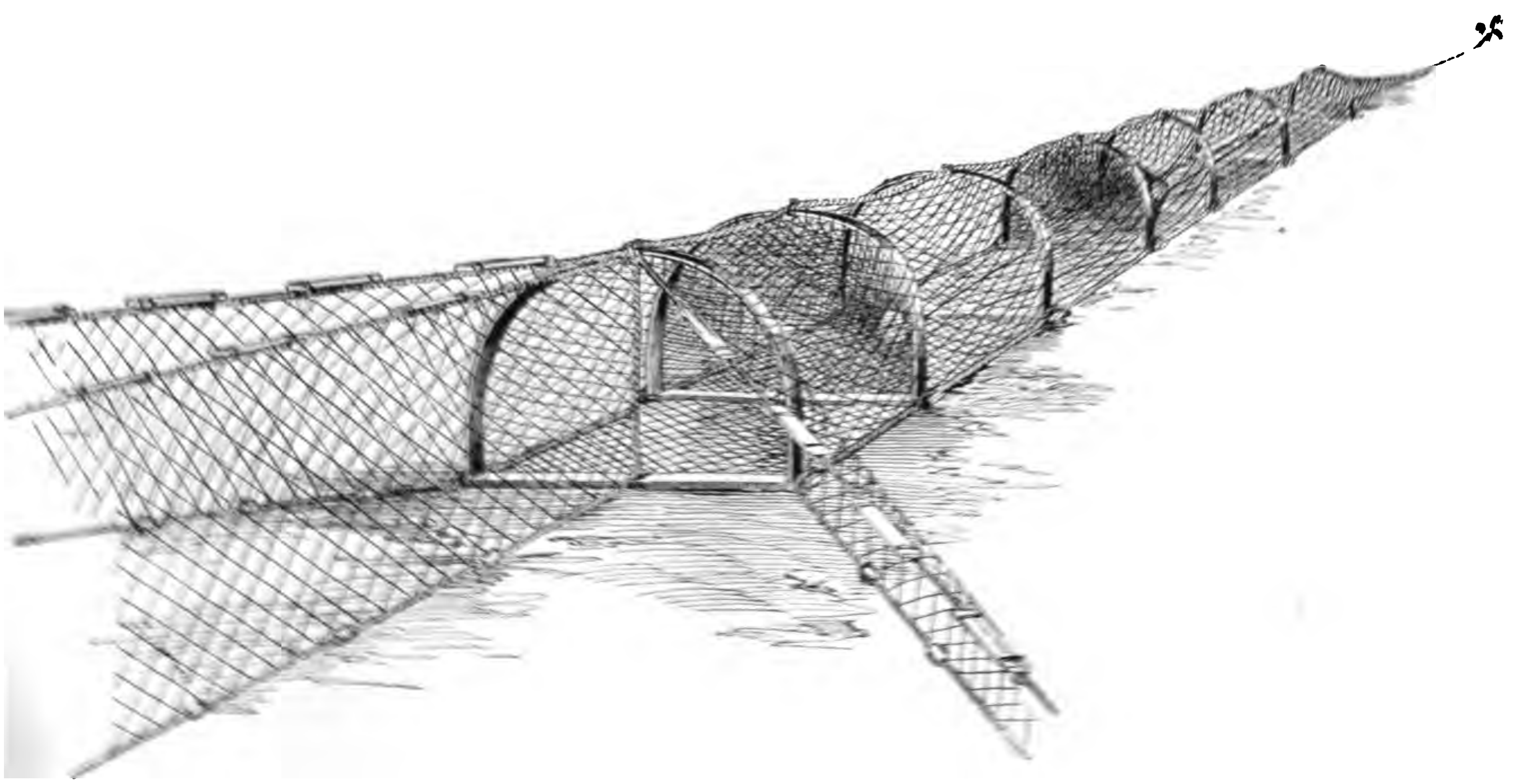
Fig. 3. "FUNNEL-MOUTH POUND." VIRGINIA.



METHOD OF SETTING DOUBLE FYKE NETS FOR SHAD. LEADERS OF TWINE AND BRUSH. HUDSON COUNTY, NEW JERSEY.







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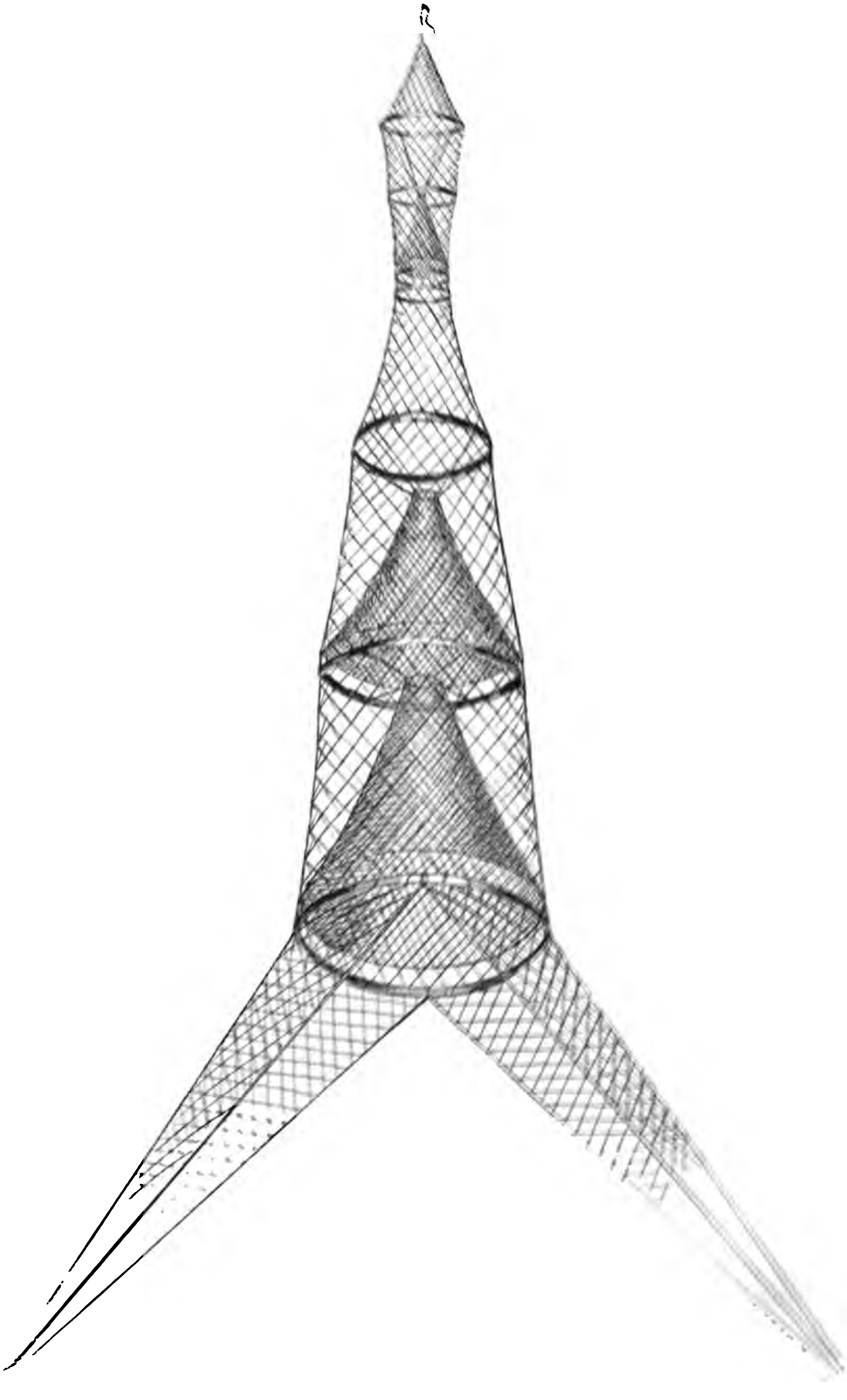

FYKE (RUSE) EMPLOYED IN SALT-WATER FISHERIES OF NORWAY.

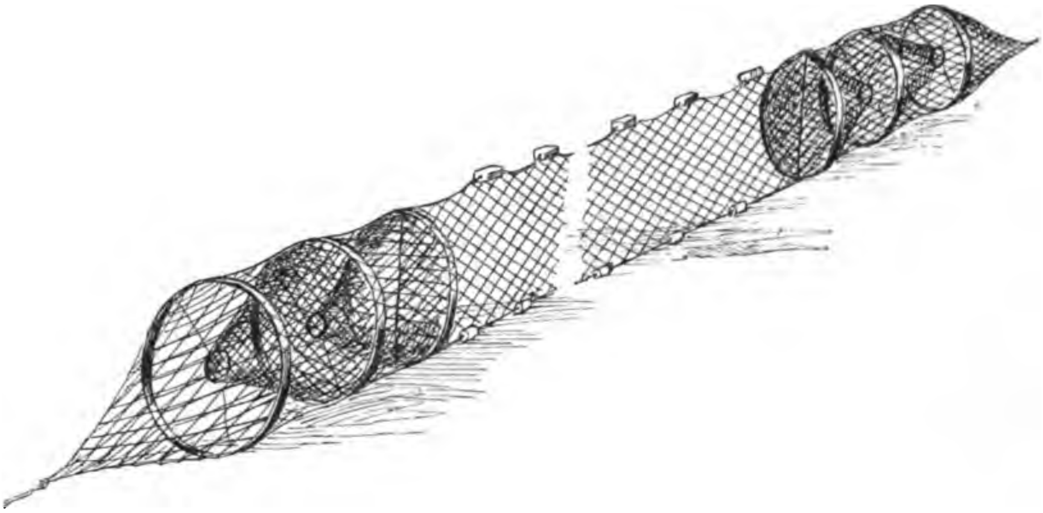

Fig. 1. FYKES SET AT END OF A COMMON LEADER. NORWAY.

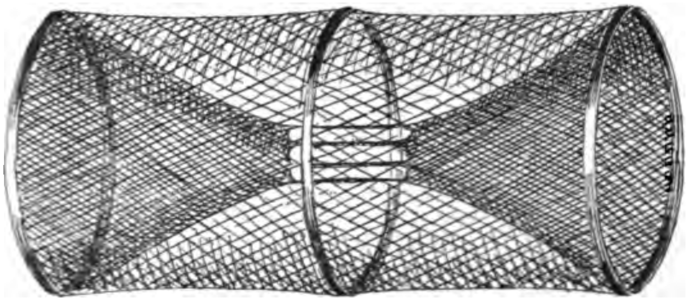

Fig. 2. ROUND FYKE (BOLLREUSE). PRUSSIA.

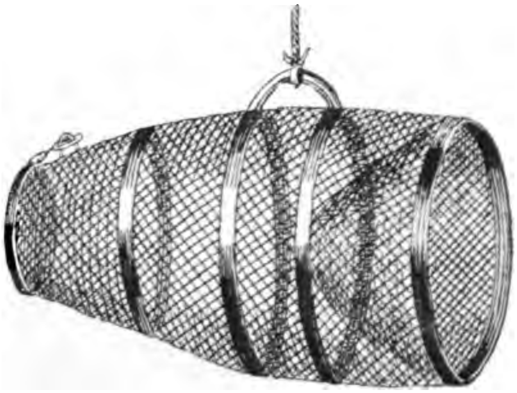

Fig. 3. POT-LIKE FYKE (MUZUAR). PORTUGAL.

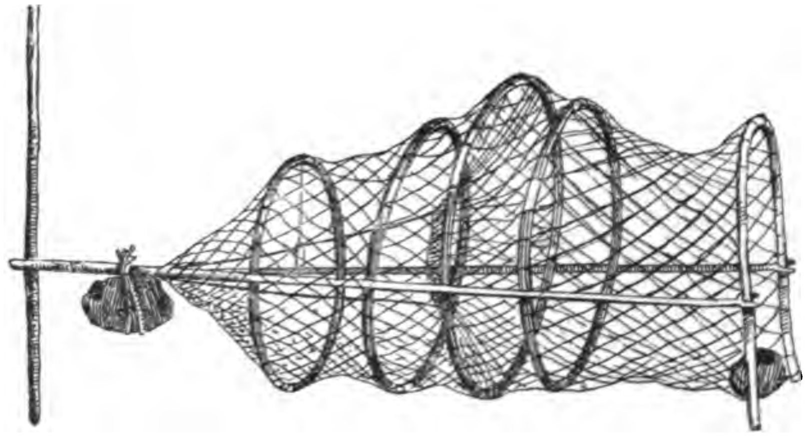

Fig. 4. SET FYKE (BOTIRÃO DE DEITAR) PORTUGAL.

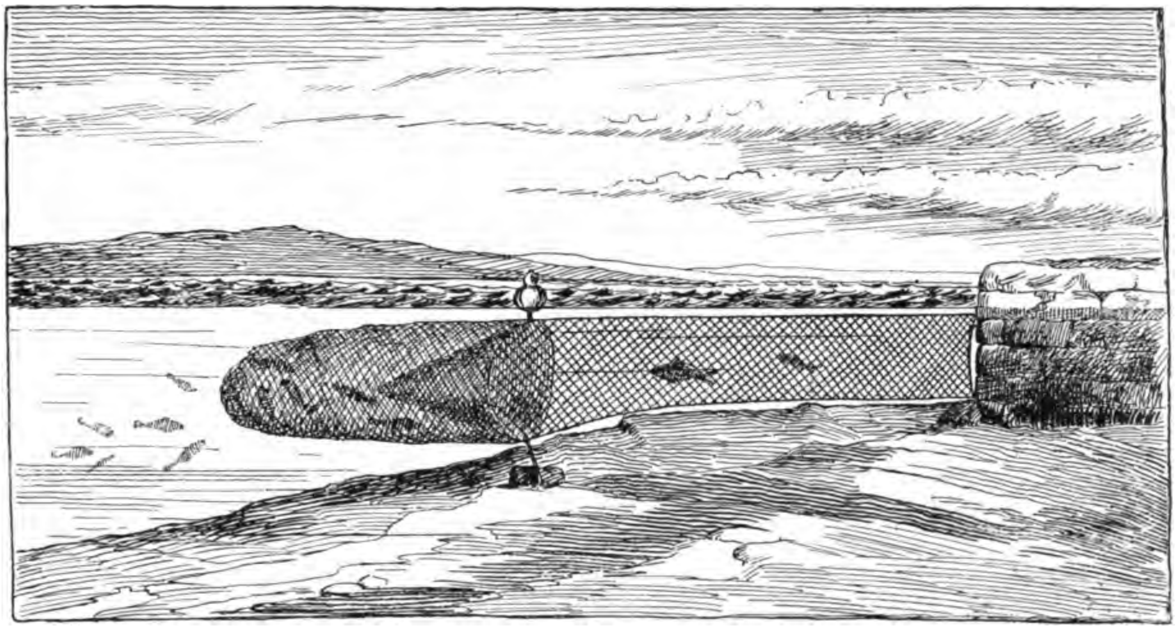

Fig. 1. BUOYED AND WEIGHTED FYKE (BOTIRÃO). PORTUGAL.

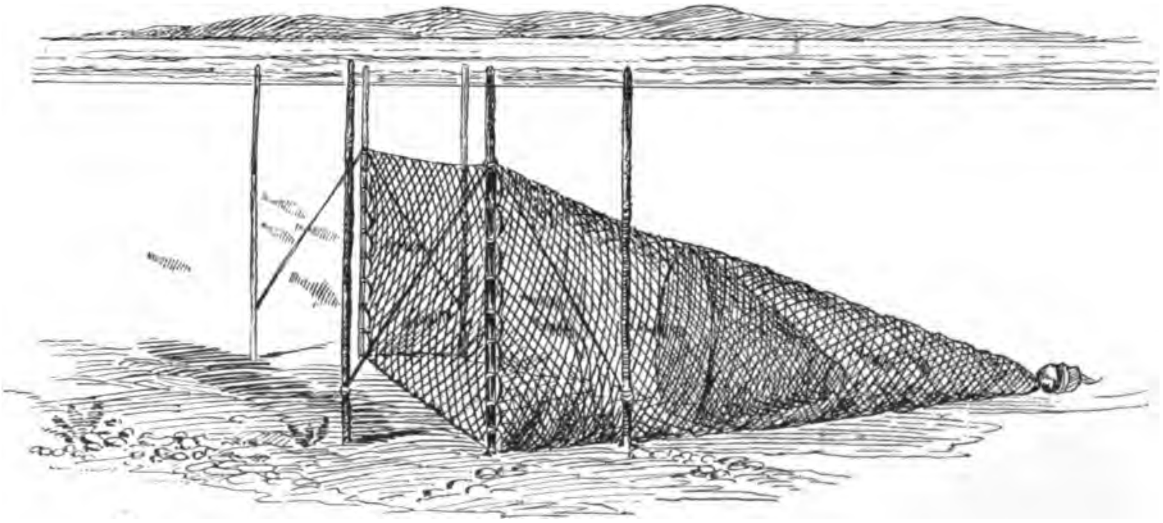

Fig. 2. STAKED FYKE (BOTIRÃO FIXO). PORTUGAL.

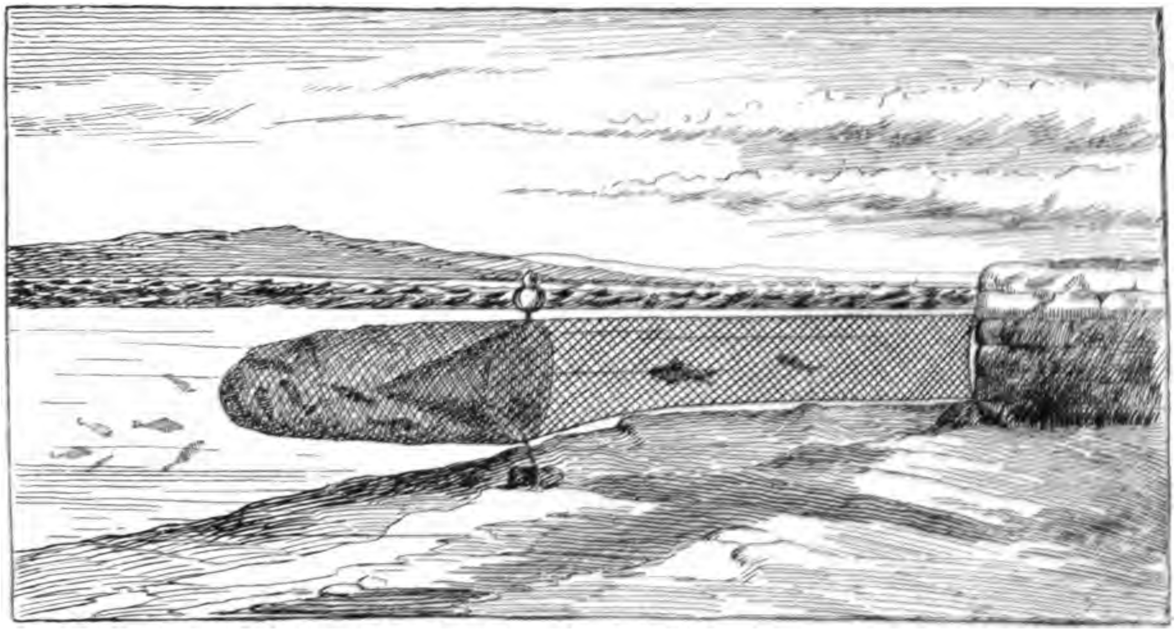

Fig. 1. BUOYED AND WEIGHTED FYKE (BOTIRÃO). PORTUGAL.

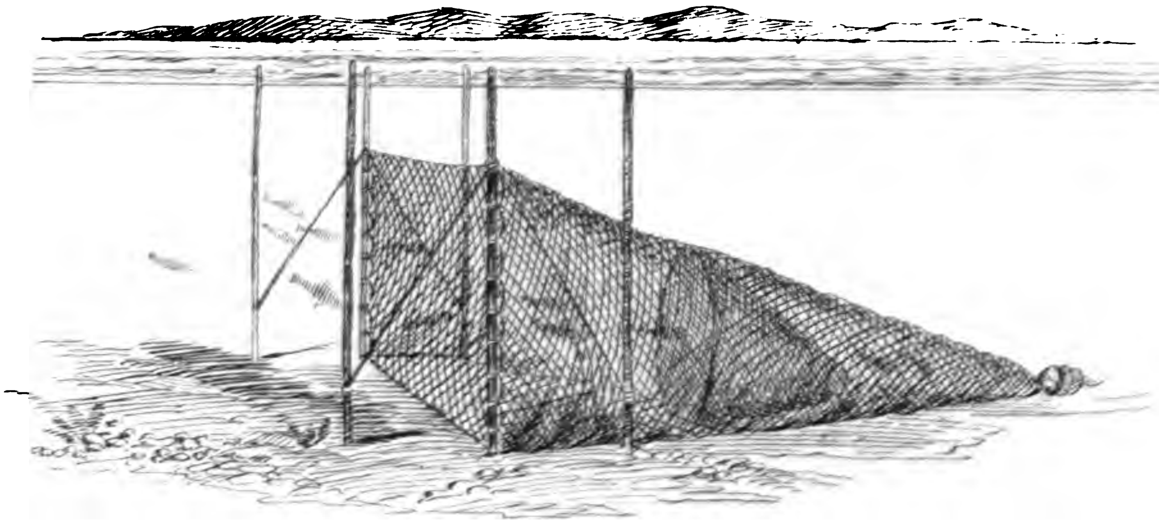

Fig. 2. STAKED FYKE (BOTIRÃO FIXO) PORTUGAL.

7.—LIST OF FISHES COLLECTED AT SEA ISLE CITY, NEW JERSEY, DURING THE SUMMER OF 1892.

BY H. F. MOORE.

In the summer of 1892 the writer was attached to the Marine Biological Laboratory of the University of Pennsylvania, at Sea Isle City, N. J. During the period from June 25 to September 1 all fish taken at the laboratory passed through his hands, and the notes made thereon are embodied in the present paper.

Sea Isle City is located upon Ludlam Beach, an island about 10 miles south of Great Egg Harbor Bay, where observations upon the fishes were made by Prof. Baird in 1854 and by Dr. Bean during the summer of 1887. In 1871 Prof. Verrill published, in the American Naturalist, a short list of the fishes observed in Great Egg Harbor Bay, with notes upon their food.

Most of the species enumerated in the present list were taken in the pound net which the laboratory established in Ludlam Bay, a shallow body of salt water (its salinity being about 5 degrees less than in the ocean on the other side of the island), several square miles in extent, communicating with Corson Inlet at the north and Townsend Inlet at the south end of the island. The depth of water is, in most places, not over 3 feet at low water, and a large area of mud flat is left bare by the tide. The tide rises about 5 feet in the bay, being one hour later than in the ocean, and the temperature of the water is several degrees warmer than in the ocean. The thoroughfares are tortuous channels with low-lying banks and rapid tidal currents.

Zostera grows luxuriantly over a large part of the bay, and *Ulva*, *Fucus*, and other algæ abound. The bottom is a vile-smelling mud containing much organic matter. Worms, crustaceans, etc., furnish an abundant food supply in the bay.

The notes which follow relate to marine fishes only, no effort having been made to investigate the fauna of the adjacent mainland. Sixty-one species are enumerated and of these about thirty-five species are represented by young. A systematic investigation would doubtless reveal a number of forms not included in this list but found by Dr. Bean at Great Egg Harbor Bay.

The following species, recorded by neither Prof. Baird nor Dr. Bean, were taken by the writer: *Carcharias littoralis*, *Clupea sapidissima*, *Echeneis naucrates*, *Decapterus punctatus*, *Caranx chrysos*, *Vomer setipinnis*, *Mullus surmuletus auratus*, and *Balistes carolinensis*. Two of these, *Clupea sapidissima* and *Mullus surmuletus auratus*, are of considerable interest.

Three species noted by Prof. Baird, but not by Dr. Bean, are to be recorded from Sea Isle City, namely: *Ophidion marginatum*, *Pogonias cromis*, and *Opisthonema oglinum*. Two specimens of the former were taken during the summer; Prof. Baird's specimen was taken in winter.

Most of the notes from Avalon were made by J. Percy Moore.

1. **Raia eglanteria** Lacépède. *Brier Ray.*

This is the common ray here and is frequently caught by fishing parties in the inlets. Specimens are occasionally found upon the beach and seined in the surf. One was taken in the pound net in Ludlam Bay.

2. **Raia lævis** Mitchill. *Barndoor Skate.*

A small individual of this species was seen at Avalon June 26. No other specimens were found.

3. **Dasyatis centrurus** (Mitchill). *Stingray.*

This species is exceedingly abundant and was taken in the pound net in numbers throughout June, July, and August. After about August 20 all the specimens taken were young of the year, the adults apparently deserting the bay after bringing forth their progeny. Two broods of young, one of four, the other of five, were born in the aquarium August 10 and 15, respectively. In neither case did the mother survive the birth more than a few hours. The parents measured about 2 feet across the "wings;" the young were about 5 to 6 inches. The "uterus" of the mother was clothed internally by a dense mat of vascular villosities, which by some means convey nutritive material to the developing young.

4. **Galeus canis** (Mitchill). *Dogfish.*

This shark is very abundant, usually appearing in packs to the great annoyance of fishermen. It was caught daily, in the pound net, throughout the summer, but greatly increased in abundance during the latter part of August.

5. **Carcharhinus obscurus** (Le Sueur). *Man-eater.*

Several sharks of this species were taken in the pound net during the latter part of July. Seen on Five Fathom Bank August 8. A "large shark 10 feet long," probably this species, was seen in Ludlam Bay August 18.

6. **Carcharias littoralis** (Mitchill). *Sand Shark.*

Three specimens, about 5 feet long, lived for some time in the aquaria. Two of these were caught in Ludlam Bay early in June; the third about July 10. They all showed a very ferocious disposition.

7. **Etrumeus sadina** (Mitchill). *Round Herring.*

This species was found in pools on the beach above the laboratory. Large numbers became stranded along shore during the first week in August, when bluefish were abundant off the coast.

8. **Clupea sapidissima** Wilson. *Common Shad.*

A number of specimens, about 6 inches long, were taken in the pound net during the middle of August. Great Egg Harbor River, 10 miles north of Ludlam Bay, is the nearest stream in which they are known to breed. The captures extended over a period of eight or ten days and but two or three specimens were taken at a time. But little is known of the shad from the time it leaves its native waters at the end of its first summer until it returns as an adult fish intent upon the propagation of its kind. Dr. Bean writes:

> Young shad measuring 5 to 7 inches in length have been seen in the Potomac in company with the adults in spring. Mr. Worth caught many specimens several years ago at Fort Washington. We have occasionally found shad measuring 5 or 6 inches in length in the fall of the year, before the time for their descent to the sea. Whether or not they are the young of the year is unknown to me.

According to Dr. G. Brown Goode, at the time the young fish are leaving the waters in which they were hatched they are said to be from 2 to 3 inches long. If this be true, as my observations upon the herring lead me to believe, the specimens under discussion are from eggs hatched during the spring of the preceding year, perhaps some time in April, and are consequently fifteen or sixteen months old. They have increased but 3 to 4 inches in length during eight or ten months. It would be interesting to determine whether shad of this size *regularly* occur in the almost landlocked waters of the shallow bays along the coast of southern New Jersey. It seems improbable that they so occur in numbers. This question might, perhaps, prove of economic importance.

9. **Clupea pseudoharengus** Wilson. *"Herring."*

Young specimens, 5 inches long, frequently taken in Ludlam Bay during August. Captured in pound net. An active species abundant in ditches communicating with Ludlam Bay. Occasionally infested with *Lerneonema radiata.*

10. **Clupea æstivalis** Mitchill. *Glut Herring.*

Several specimens, 5 to 6 inches long, taken during the middle and latter part of August.

11. **Opisthonema oglinum** (Le Sueur). *Thread Herring.*

Several specimens were taken in pound net.

12. **Brevoortia tyrannus** (Latrobe). *Menhaden.*

The most abundant fish in the bay throughout July and August. Adults caught in great numbers in pound net. Young ones, from 3 to 4 inches long, very plentiful during August. Adults almost without exception infested with *Lerneonema radiata,* some bearing ten or twelve of these conspicuous parasites. None of the young were parasitized.

13. **Stolephorus browni** (Gmelin). *Anchovy.*

Found in the tide pools along the beach. Several specimens, 5 to 6 inches long, were taken in pound net about August 20.

14. **Stolephorus mitchilli** (Cuvier & Valenciennes).

Seen in the pools along the beach with *Menidia notata.* Large numbers driven ashore at Avalon, August 6, by bluefish.

15. **Synodus fœtens** (Linnæus), *Lizard-fish; "Frostfish."*

A specimen about 8 inches long was taken in the pound net August 25. Said by fishermen to be common in the fall during the cool weather, whence its local name. It is said that at that season it takes the bait intended for nobler game, and is thus a source of annoyance to fishermen.

16. **Cyprinodon variegatus** Lacépède.

Very abundant in the ditches and about the shores of Ludlam Bay and the communicating thoroughfares. Found associated with *Fundulus heteroclitus, F. majalis,* and *Menidia notata.*

17. **Fundulus majalis** (Walbaum). *Killifish.*

The young are very abundant in the ditches; the adults are more frequently found amongst the *Zostera* of the tide-water flats. The species is sluggish and stupid, and full-grown specimens may often be caught in the hand.

18. **Fundulus heteroclitus** (Linnæus). *Mummichog.*

Very abundant. Found with the preceding.

19. **Anguilla chrysypa** Rafinesque. *Eel.*

Very abundant in ditches, inlets, and bay. Very many caught in pound net. Seined in numbers at Corson Inlet. Taken on hand lines. The writer on July 1, 1886, saw many hundreds of large eels lying dead or dying upon sand flats in the meadows back of Ocean City, N. J. A high tide during the night had flooded the meadows and presumably carried the eels upon the flats. As the tide went out the fish became stranded and were seemingly unable to again reach the sluices, many of them lying helpless upon the very verge of the waterways. This occurrence seems remarkable. Why should a creature gifted with the eel's reputed capacity for terrestrial migration submit to slow desiccation and eventual death with water but a few feet away?

20. **Tylosurus marinus** (Bloch & Schneider). *Gar; Silver Gar.*

Specimens half grown frequently taken in pound net during July. None taken during August. Young, from 3 to 6 inches in length, taken in Ludlam Bay during the latter part of July and abundantly throughout the month of August.

21. **Mugil curema** (Cuvier & Valenciennes).

Abundant in Ludlam Bay. Many specimens, 2 to 3 inches long, were taken in pound net during August. No larger ones were seen. Usually in company of ***Menidia notata***.

22. **Mugil cephalus** Linnæus. *Striped Mullet.*

Two specimens, 5 to 6 inches long, were taken in pound net August 10. Several others taken later in August. All about the same size. This and the preceding are hardy fish, living well in confinement.

23. **Menidia notata** (Mitchill). *Silversides.*

Very abundant along the beach and swarming in the bay. Young taken.

24. **Apeltes quadracus** (Mitchill). *Three-spined Stickleback.*

Very abundant on the mud flats in Ludlam Bay. An active species, always flocking about when the muddy bottom is disturbed. Taken throughout July and August.

25. **Siphostoma fuscum** (Storer). *Pipefish.*

Abundant in the eelgrass of Ludlam Bay. Specimens, from 3 to 6 inches long, taken during July and August.

26. **Hippocampus hudsonius** De Kay. *Sea-horse.*

One specimen taken in pound net August 5.

27. **Echeneis naucrates** Linnæus. *Suckfish.*

A specimen about 15 inches long was brought to the laboratory August 8. It was found upon the beach.

28. **Scomber colias** Gmelin. *Chub Mackerel.*

One specimen taken in pound net August 15.

29. **Sarda sarda** (Bloch).

One specimen taken in pound net July 1. Another found upon the beach at Avalon.

30. **Decapterus punctatus** (Agassiz). *Scad; Round Robin.*

Several young specimens were taken at Avalon August 7 and 8, during a bluefish foray upon the coast.

31. **Caranx chrysos** (Mitchill).

Two specimens, about 8 inches long, were taken in pound net early in August.

32. **Caranx hippos** (Linnæus).

Young specimens exceedingly abundant in the bay and along the beach during the latter part of July and throughout August. None over 4 or 5 inches long.

33. **Vomer setipinnis** (Mitchill). *Moonfish.*

Several specimens, 3 inches long, taken in pound net about August 26, with the succeeding species.

34. **Selene vomer** (Linnæus). *Dollar-fish.*

A specimen 2½ inches long was taken in pound net July 20. Another was seined in the surf July 29. During August the young became very abundant in the bay and entered the pound net in schools. They are quite voracious and when kept in confinement gradually relieve one another of filamentous rays and caudal fins. No adults were taken.

35. **Trachinotus carolinus** (Linnæus). *Pompano.*

A specimen about three-fourths of an inch long was taken during the first week in July. Several others were afterwards caught, and several small bunches of 10 or 12 each were seen about the wharf in the bay during August. None of these was over an inch long. Like the following species, they swim at or near the surface.

36. **Seriola zonata** (Mitchill). *Pilot-fish.*

During the first week in July a specimen 5 inches long was taken in the pound net. They are common about the piling of bridges across the inlets. They commonly swim with the dorsal fin just breaking the surface of the water.

37. **Pomatomus saltatrix** (Linnæus). *Bluefish.*

A young bluefish was taken in the pound net during the last week in July and the first school was reported at about the same time. August 4 a school came close inshore in pursuit of butter-fish and other species which were frequently stranded in numbers in endeavoring to escape their voracious pursuers. Henceforward the species was common and many were taken by fishing parties. During August great numbers of young, from 4 to 8 inches long, appeared in the bay.

38. **Stromateus triacanthus** Peck. *Butter-fish.*

First appeared August 4, when numbers were found on the beach and captured by bathers in the surf. A few days later they became abundant in the bay, being driven there by the bluefish. They continued to be caught throughout the month.

39. **Roccus lineatus** (Bloch). *Striped Bass; "Rock."*

A small specimen taken in pound during the first week in July. Two fine specimens were caught in the surf at Avalon by Charles Sutton August 9. Others were reported caught on lines at Townsend Inlet during August.

40. **Centropristis striatus** (Linnæus). *Sea Bass; Black Bass.*

Great numbers of this species, from 1 to 2½ inches long, were caught in the *Zostera* ("eel grass") of Ludlam Bay August 20. We dredged specimens of the same size in 3 fathoms, shelly and muddy bottom, in Great Channel and Townsend Inlet. Specimens about 6 inches long are taken on hand lines and frequently enter the pound net. Larger ones, up to 3 pounds in weight, are very abundant on Five Fathom

Bank, biting voraciously on clam bait. They live well in captivity, spending most of their time on the bottom of the aquaria, resting, tripod-like, on the ventral and anal fins.

41. **Stenotomus chrysops** (Linnæus). *Scup; Porgy.*

Six or eight specimens, from 6 to 8 inches long, were taken in Ludlam Bay at various times during July and August. Very abundant on Five Fathom Bank, where many fine ones are taken by hook and line.

42. **Archosargus probatocephalus** (Walbaum). *Sheepshead.*

One taken in seine at Avalon in July. Several caught by fishermen at Townsend Inlet July 30.

43. **Mullus surmuletus auratus** Jordan & Gilbert. *Red mullet.*

A specimen of this much-prized fish was taken in the pound net July 26. Another specimen was captured by the same means August 10. Both were young fish, the first captured being 2½ inches from snout to base of caudal fin; the second was a little longer, about 2⅝ inches. The color was red, becoming pale below and in the living fish having a nebulous or cloud-like arrangement, particularly in the head and pectoral region. Below the lateral line the sides were traversed by four narrow longitudinal yellow stripes, the upper two running from head to tail, the inferior two extending from behind the pectoral fin to the level of the middle of anal. Dorsal and caudal fins yellow, crossed by irregular dusky bands; the other fins plain. Eye, 3¾ in head. Head, 3⅓ in length. Depth, 3¼ in length. Lateral line, 34. Barbels, 1¼ in head, reaching beyond lower angle of opercle.

These specimens are, the writer believes, the only recorded captures of young red mullets on our coast. That they are young of the year seems probable, but apparently nothing is known of the rate of growth and breeding of this fish, even in Europe, where they are commercially important. They are supposed to spawn at sea, but even this is uncertain. The red mullets are bottom fish, and in the aquaria spent most of their time resting upon their anal and ventral fins, like the sea bass, or moving slowly about exploring the bottom with their barbels. This species is recorded from Woods Hole, New York, and Pensacola. Prof. Jordan writes that seven or eight specimens have been taken on our coast, all of which were adults.

44. **Pogonias cromis** (Linnæus). *Drumfish.*

One specimen, 44 inches long, was caught in pound net June 27. Ten or twelve large parasitic worms were removed from the muscles of the body and tail. The gill filaments were also swarming with lerneans and other parasites. A second rather smaller specimen was taken July 15. These fish appear very stupid, and when caught in the net roll over on one side and permit themselves to be picked up without a struggle.

45. **Bairdiella chrysura** (Lacépède). *"White Perch."*

One specimen caught in pound July 15.

46. **Leiostomus xanthurus** Lacépède. *Spot; Porgy.*

Young, 3 to 5 inches long, abundant in the bay and alongshore throughout July and August.

47. **Menticirrhus saxatilis** (Bloch). *Kingfish; "Hake."*

Several, about 12 inches long, were taken in pound net during July and August. It was frequently caught by fishing parties in the inlets.

48. Cynoscion regalis (Bloch & Schneider). *Weakfish.*

A very abundant food-fish. Many were taken in pound net in Ludlam Bay during July and August. The catch was irregular, some days fifty or sixty being taken and then for several days succeeding perhaps none. Many were caught by fishing parties in the inlets, and during August they were successfully fished for in Ludlam Bay. At the same time the young, 2 to 3 inches long, were common.

49. Tautoga onitis (Linnæus). *Tautog; "Sea-tog."*

A single sea-tog was taken in a seine upon the beach at Avalon August 4. No other noted during the summer.

50. Gobiosoma bosci (Lacépède).

Many specimens were drawn in a dredge from a shell bottom in Great Channel. Depth, 3 to 4 fathoms. Abundant throughout the summer in Ludlam Bay. All specimens taken were about 1½ inches long.

51. Batrachus tau (Linnæus). *Toadfish; "Oyster-fish."*

A very common fish in Ludlam Bay and frequently taken in pound net. Takes the hook freely. It delights to lie in the pools on the mud flats at low water, often barely covered by the tide. Its color and general appearance is in such excellent mimicry of its surroundings that it is by no means readily detected as it lies midst decaying *Ulva* and other algæ. Eggs about hatching were found during the first week of July, attached in patches of 50 to 100 to the under side of logs and clumps of turf lying near low-water mark. The young, after hatching, remain for some time fixed upside down by the yolk sac to the attached base of the egg "shell." The male guards the eggs and newly-hatched young, savagely resenting any intrusion. These fish are extremely tenacious of life, and specimens were kept alive without water for sixteen to eighteen hours.

52. Ophidion marginatum De Kay.

Two specimens taken at Townsend Inlet; one, about 3 inches long, lying dead on sand bar, the other, 8 inches long, buried in sand of beach near low-water mark.

53. Pleuronectes maculatus Mitchill.

A specimen, 6 inches long, was taken in pound net.

54. Paralichthys dentatus (Linnæus). *Common Flounder.*

Common. Frequently taken in pound net and with hook and line. Young, 4 to 5 inches long, abundant in Ludlam Bay in August. One weighing over 5 pounds captured with hook and line in the thoroughfare at Avalon August 6. Valued as a "pan" fish.

55. Achirus fasciatus Lacépède. *Sole.*

A specimen, about 6 inches long, taken in pound net August 1. This fish swims close to the bottom, stirring up the mud and effectually masking its movements.

56. Balistes carolinensis Gmelin. *Trigger-fish.*

One taken on line at Townsend Inlet August 4.

57. Alutera schœpfii (Walbaum). *"Sunfish."*

One taken in pound net. Two others found on beach. Others seen upon several occasions at Townsend Inlet. All adults. A young specimen, 6 inches long, of this or an allied species was found on the beach in August.

58. Orbidus maculatus (Bloch & Schneider). *Swellfish.*

One specimen, about 3 inches long, was taken in pound net August 2.

59. **Chilomycterus schoepfi** (Walbaum). *Burr-fish.*

Common during July, a number of specimens being taken in pound net during that month. All adults. None seen during August.

60. **Prionotus carolinus** (Linnæus). *Sea Robin; Flying-fish.*

Very common during July and August in Ludlam Bay. Specimens mostly 8 to 10 inches long, none longer. Young, 3 to 4 inches long, taken in August.

61. **Prionotus strigatus** Cuvier & Valenciennes. *Flying-fish.*

Specimens about 4 inches long common in Ludlam Bay during latter part of July and throughout August. No adults taken.

8.—ECONOMIC AND NATURAL-HISTORY NOTES ON FISHES OF THE NORTHERN COAST OF NEW JERSEY.

BY HUGH M. SMITH, M. D.

GENERAL FEATURES OF THE FISHERIES.

On few parts of the Atlantic coast of the United States are the fisheries of more importance than on the ocean shore of New Jersey. Not only are the commercial fisheries of the region of great value, but pleasure fishing is carried on very extensively; and the antagonism which for many years has existed between the professional fishermen and the sportsmen attracts much public attention and often excites very acrimonious discussion in the public press and the most active rivalry in and before the State legislature. It is not within the province of this paper to discuss the merits of the opposition to various forms of net fishing, or to attempt any settlement of the differences of opinion which prevail as to the propriety of certain branches of the economic fisheries. The few notes that are presented are intended simply to exhibit certain facts relative to the abundance, movements, importance, etc., of some of the most valuable fishes of the coast.

This paper is based on personal observations made on the New Jersey coast by the writer during parts of the years 1886, 1888, 1892, and 1893, while investigating the commercial fisheries in the service of the U. S. Fish Commission, and largely represents a study of the pound-net fisheries of the northern part of the coast. A much greater variety of fish is taken in the pound nets than with any other form of apparatus, larger quantities of products are thus secured than with any other kinds of nets, and the fishery is the most important one prosecuted with nets on this coast.

A small number of pound nets are operated on the outer shore of New Jersey in Monmouth and Ocean counties, to which the fishery is restricted. In Sandy Hook and Delaware bays, however, a large number of nets are set, chiefly for shad and king crabs. From many points of view the nets on the ocean shore are more important, and it is only with them and the results of their use that this paper has to deal. Pound nets have been set in limited numbers on this coast for many years, but of late the number has been greatly augmented, and the fishery is now more important than ever before, both on account of its increased extent and because of the growing attention which all forms of net fishing, especially that for game fish, so called, are receiving at the hands of sportsmen and legislators.

The early history of the pound-net fishery on this coast is interesting. It is recorded* that pound nets were first introduced into this region about 1855, by Mr. George Snediker, of Gravesend, Long Island. The first nets were of small size, and were set in Sandy Hook Bay for protection from storms. It was not until 1873 that pound nets came into general use, and it was about that year that they were first operated on the outer shore.

Twenty-three pound nets, located between Mantoloking on the south and Galilee on the north, were in use in 1892. Twelve nets were operated in 1891, 7 in 1890, and 8 in 1889. The principal increase in the later years has been in the region south of Asbury Park. Most of the nets are set singly or in twos, but at Galilee in 1892 there were two stands containing three nets each. The nets have an average value of about $2,500, and require the services of 7 to 9 men. The 23 nets operated in 1892 had an aggregate value of $57,140; the 33 boats used were worth $5,545; the accessory and shore property required to conduct the fishery was valued at $20,821; and 167 fishermen found employment.

In 1889 the 8 nets took fish worth $51,625; the following year 7 nets stocked $50,141; the value of the catch in 12 nets in 1891 was $84,927; and in 1892 $169,949 accrued from the yield of 23 nets. These sums represent the gross value of the fish as received by the fishermen. The quantities and values of each of the prominent fishes taken in 1891 and 1892 are shown in the table. The great abundance and importance of the weakfish are well illustrated, about two-thirds of the proceeds from the pound-net fishery representing this fish. The next important species are Spanish mackerel, flounders, butter-fish, sea bass, bluefish, sheepshead, shad, bonito, and mackerel.

Products of the pound-net fishery of the Northern Coast of New Jersey in 1891 and 1892

Species.	1891.		1892.	
	Pounds.	Value.	Pounds.	Value.
Albacore	1,176	$40	4,010	$136
Blackfish	12,437	261	4,435	91
Bluefish	75,999	2,847	99,313	3,898
Bonito	54,733	2,141	68,318	2,737
Butter-fish	110,052	2,721	256,142	7,231
Cero	847	38	3,610	172
Cod	2,294	64	4,659	110
Flounders	177,267	3,961	513,247	10,814
Kingfish	2,247	278	2,503	366
Mackerel	25,017	2,304	22,307	2,660
Menhaden	28,510	74	37,665	113
Sea bass	29,188	946	142,715	5,947
Scup	12,982	311	36,900	1,125
Shad	29,968	1,822	46,863	3,208
Sheepshead	17,240	2,629	25,737	3,774
Spanish mackerel	33,781	4,525	71,663	9,767
Spot	1,080	21	3,482	39
Sturgeon	11,430	204	35,312	729
Weakfish	2,694,299	59,326	5,446,390	116,377
Miscellaneous	23,501	414	40,878	655
Total	3,344,048	84,927	6,866,149	169,949

As bearing on the abundance or scarcity of fish, the following averages possess considerable interest. Assuming that there is only a limited supply of fish on this part of the coast each year and that a given number of nets take a certain quantity of fish, it might be supposed that a very marked increase in the number of nets operated would result in a diminution in the average catch per net. In 1880, when there were 11 pound nets set on this shore, the average stock was somewhat greater than in recent years, although the average quantity of fish taken was a little less. Comparing 1889 with 1892, it appears that, although the number of nets in the latter year was about three times the number in the former, the average catch and stock were greater.

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* The Fisheries and Fishery Industries of the United States, section II, p. 389.

Years.	No. of nets.	Average catch per pound net.	Average stock per net.
		Pounds.	
1880	11	248, 980	$7, 980
1889	8	247, 270	6, 453
1890	7	281, 160	7, 167
1891	12	278, 670	7, 076
1892	23	298, 525	7, 389

The influence of pound nets on the abundance and movements of fishes is a question which can not be answered off hand and which involves a comprehensive knowledge and careful study of the natural conditions determining the migrations and periods of abundance and scarcity of our fishes. Probably the time is not far distant when it will become an obvious necessity in some States to place more stringent regulations on the use of pound and other nets in certain situations, as, for instance, in the mouths of rivers, where the decrease in the catch of shad, sturgeon, salmon, etc., may often be clearly traced to the taking of fish on their way to the spawning-grounds in such numbers that the reproductive process is practically inhibited; but it is a well-recognized fact that pound and other nets which are set in the open waters of the ocean and take chiefly free-swimming marine fishes are the least likely to do serious damage and afford the least ground for apprehension.

Perhaps the most valid and forceful objection that has been made against the pound nets on this coast is that there is a large destruction of immature and small fish that are unmarketable. This criticism is applicable to most of the pound fishing in this country. It is not generally denied by the pound fishermen that many fish too large to go through the meshes of the nets and too small to be marketed are caught and, by the nature of the fishery, necessarily sacrificed. The same objection is justly advanced against much of the seine fishing on our coast. No entirely satisfactory remedy has as yet been suggested for this condition. The enlargement of the mesh in the bowl of the pound nets will not completely overcome present objections and will introduce elements of expense and trouble which the fishermen wish to avoid. The fishermen say that, unless the size of the mesh is made so large that many of the marketable fish will escape, the fish sought to be preserved will be gilled, and thus as effectually destroyed as with a small mesh, while the time and labor required to clear the net of the gilled fish would make the prosecution of the business almost impracticable. The remedy which seems to afford the most relief is to require the pound operators to lift the nets more frequently than is usually done, to liberate all small fish, and bring to the shore only such fish as are marketable. The principal species of which large numbers of small individuals are destroyed on the New Jersey coast is the butter-fish. The fish is naturally a small one, rarely exceeding half a pound in weight and averaging only one-third of a pound. The great relative depth of the body of the fish makes it impossible for even very young ones, in which this feature is intensified, to go through the meshes of the pocket. The destruction of immature bluefish, weakfish, and other fish by pound nets on this coast is insignificant.

NOTES ON THE FISHES OF THE REGION.

The following remarks on the abundance, movements, etc., of some of the fishes found on the New Jersey coast relate more particularly to the region north of Barnegat Inlet, and, as has been stated, are chiefly based on a study of the pound-net fishery. Only the common names heard in the region are given.

1. **Raia eglanteria** Lacépède. *Possum; Sea Possum; Bob-tailed Skate.*

Large numbers are caught in pound nets. They are valueless, and are a source of annoyance to the fishermen. Other more desirable fish are usually absent or scarce when skates are abundant on the shores. On July 8, 1892, not less than 10,000 pounds were turned out of one net at Bradley Beach. The fish weigh from 1 to 5 pounds.

Some sport fishing is afforded by these fish along parts of the coast, the hook being baited with crab, clam, or fish. At times the fish move close inshore, and numbers are often caught from the piers.

In the trawl-fishing carried on from parts of this coast in winter considerable quantities of skates are caught in company with cod and conger eels. The broad, fleshy "wings" are cut off and sold under the name "saddles," the price received being about 5 cents a pound. Some of these saddles weigh 10 pounds or more. From descriptions furnished by the fishermen it appears that the skate taken in greatest numbers in this fishery is the barn-door skate (*Raia lævis*), which reaches a larger size than any other skate found on our shores.

2. **Dasyatis centrurus** (Mitchill). *Stingray; Stingaree; Pigeon Stingray.*

Common. Examples weighing 150 pounds are taken in the pound nets, but such large specimens are not very common. An example, the body of which was 3 feet wide, was observed July 11 at Bradley Beach. The fishermen always handle this fish with great care, and some of them usually break off the caudal spine with an oar before returning the fish to the water. Stories are told of ugly wounds inflicted by the fish in the feet, legs, and hands of incautious fishermen.

3. **Acipenser sturio oxyrhynchus** (Mitchill). *Sturgeon; Moose.*

Occurs on the coast from April to October, and is taken in pound nets in small quantities during the seven months of the pound-net season. It is most common in May and June. It is shipped to market in a dressed condition, and usually brings from 3 to 5 cents a pound. Small fish, called "moose," are sold whole; the name appears to be a corruption of "mammoose," which is current in Delaware Bay, and is applied to young fish that are too small to dress and are usually sold whole.

4. **Clupea mediocris** Mitchill. *Shadine; Herring.*

Small quantities are taken in the pound nets during the run of shad. They are sold at 5 to 12 cents apiece. The name shadine is in common use in many places.

5. **Clupea pseudoharengus** Wilson. *Herring.*

6. **Clupea æstivalis** Mitchill. *Herring.*

Limited quantities of these two fishes are caught in spring in pound nets. They have little value, however, hardly pay the expenses of shipment, and are usually liberated when caught. In 1892 there was a small run of herring in the pound nets in September, October, and November.

7. **Clupea sapidissima** Wilson. *Shad; Jack.*

The shad occurs regularly, but not abundantly, on the outer shore in spring, and is caught in the pound nets at that season. The largest numbers are taken in April and May, as shown by the following table, giving the catch at a pound-net fishery in Monmouth County. Stragglers, however, occur through the summer, and on October 9, 1891, a ripe roe shad was caught in a pound net in Ocean County.

Months.	1891 (1 net).	1892 (2 nets).
	Number.	*Number.*
April	13	370
May	856	78
June	49	50
July	2	2
August	1	....
Total	921	500

Young male shad are called "jacks" at a number of places on the coast.

The fish are mostly shipped to New York, where the bucks bring 8 to 20 cents each and the roes 15 to 50 cents.

8. **Brevoortia tyrannus** (Latrobe). *Bunker; Mossbunker; Mossbanker.*

Very scarce on this shore in 1891 and 1892. Two pound nets in about the middle of the pound-net section had, up to the end of August, 1892, caught only 7 bushels of menhaden. The fish appeared in good-sized bodies in the spring of 1892, but they were driven off by the bluefish and weakfish and only stragglers were caught through the summer. The professional line fishermen are dependent on menhaden for their bait supply, and have to undergo considerable additional expense when the fish are scarce.

9. **Stolephorus mitchilli** (Cuvier & Valenciennes). *Sperlin.*

Exceedingly abundant at times and having an important relation to the occurrence of other fish which feed upon them. When weakfish have been scarce the advent of large schools of "sperlin" is regarded by the fishermen as an auspicious circumstance and they look for the early arrival of the weakfish. Large schools were often observed in and around the pound nets, where they were doubtless attracted by the presence of food. Two other species of anchovy (*S. browni* and *S. eurystole*) occur in abundance on this coast under the same conditions as *S. mitchilli.*

10. **Anguilla chrysypa** Rafinesque. *Eel.*

Some very large examples are often caught by the line fishermen when fishing for bluefish, sea bass, etc.

11. **Conger conger** (Linnæus). *Conger Eel; Sea Eel.*

Small numbers are taken in the pound nets, chiefly in April and May. They weigh 5 to 7 pounds and have a value of about 2 cents a pound. They are also taken in some quantities in the trawl fisheries for cod, carried on in winter.

12. **Tylosurus marinus** (Bloch & Schneider). *Billfish; Gar.*

Large schools of fish from 8 to 12 inches long were often observed in the pound nets, which they enter in search of food. When the nets are lifted they go through the meshes and are seldom caught.

13. **Exocœtus** sp. *Flying-fish.*

Flying-fish, probably *E. heterurus*, are occasionally taken in the pound nets, mostly in July. The fish weigh from one-fourth to one-half a pound and have no economic value.

14. **Scomberomorus regalis** (Bloch). *Cero; Sier; Siering; Searer.*

Not common; irregular in appearance, and apparently little more than a straggler in the pound nets. About twelve or fifteen fish are usually taken annually in each pound net. They range in weight from a few pounds to upward of 40 pounds, the average being probably 10 pounds. On August 22, 1892, an example weighing 36 pounds was taken at Long Branch, and the same day another weighing 25½ pounds was caught at Bradley Beach. The fish arrives in June, and remains on the coast into October. It is usually most common in August, as is shown by the following record of the number of fish taken in two pound nets in 1892:

Months.	Number of fish caught.
June	1
July	....
August	20
September	5
October	1
Total	27

The average price received in 1892 was 50 cents for each fish, or 5 cents a pound. At times, however, and in some places where the fish are sold locally, as at Long Branch, from 12 to 15 cents a pound is the price received.

15. **Scomberomorus maculatus** (Mitchill). *Spanish Mackerel; Spaniard.*

Next to the weakfish this is the most important fish taken in the pound nets set on the ocean shore of the State. The fish does not occur regularly, but goes in scattered bodies. Sometimes several weeks may elapse before a given net will catch any; then schools may strike on and fish be taken at each lift for quite a while. One particular net set off Monmouth County in 1887 secured 2,500 pounds of Spanish mackerel on the first and second days of August, but none was taken at any other time during that season.

The fish taken in this State have an average weight of nearly 3 pounds. The monthly variations in the catch in 1891 and 1892 are shown in the following summary:

Months.	1891 (1 net).	1892 (2 nets).
	Pounds.	*Pounds.*
July	336	5
August	1,803	3,280
September	1,598	4,030
October	51	....
Total	3,788	7,315

In 1887 7 pound nets on this coast took 17,500 pounds of Spanish mackerel, an average of 2,500 pounds to each net. The following year the same nets took about 35,000 pounds, an average of 5,000 pounds each. In 1891 12 nets secured 33,781 pounds, giving an average of 2,815 pounds to a net. The 23 nets employed in 1892 obtained 71,663 pounds, the average catch to a net being 3,115 pounds.

16. **Sarda sarda** (Bloch). *Bonito; Bonejack; Bone-eater; Skipjack.*

While a common fish on the New Jersey coast, the bonito is of irregular occurrence. It usually arrives in May and is found in the inshore waters till the latter part of September, when it leaves with the bluefish and Spanish mackerel. In 1892 a few fish were taken as early as April 28, and good lifts were made in October. The largest quantities are taken in pound nets, but occasionally good catches are made with gill nets, especially in the fall, when the fish are running south and are close inshore. The usual number secured in a pound net is only three or four at a lift, but sometimes schools of 200 or 300 fish "strike on" at a particular place and are caught, while only stragglers will be taken in any other locality on that day. The fish have the habit of splashing the water, like bluefish and Spanish mackerel; at times they were observed very near, and even in, the line of breakers and then created much visible and audible commotion. On August 21, 1892, small schools were noticed close inshore off Ocean Grove and a few examples were caught by trolling from small sailing skiffs. They are also occasionally taken from the piers at Ocean Grove, Long Branch, and other places.

The variations in the abundance of the fish are shown, by months, in the following table, which represents the catch of one pound net in 1891 and two nets in 1892, set off Monmouth County, in the middle of the pound-net section:

Months.	1891.	1892.
	Pounds.	*Pounds.*
April		28
May	8	
June	3,315	410
July	4,355	4
August	1,497	3,736
September	98	122
October		409
Total	9,273	4,709

The smallest example observed was taken in a pound net at Ocean Grove on July 11, 1892; it was 8 inches long and was the only one taken at that lift of the net. Five pounds is the average weight of the fish caught.

17. **Gymnosarda alletterata** (Rafinesque). *Apple-core; Albacore.*

Rather scarce in pound nets in summer. The few caught weigh 6 or 8 pounds. Small quantities are also taken with lines while fishing for bluefish and sea bass. Mr. Barton A. Bean, of the U. S. National Museum, communicates the following note on this fish to the issue of Forest and Stream for December 22, 1892:

> Mr. W. C. Kendall tells us of the movements of a very large school of tunny or little horse-mackerel off Barnegat. Last summer (about July 27) as the Fish Commission schooner *Grampus* was cruising along slowly, these fish made their appearance and surrounded the vessel. The school was a mile or more in diameter and consisted of fish about 3 feet in length. They schooled close up together, similar to the common mackerel. Ordinarily they would merely flirt their tails out of the water, but at other times they would leap clear out; then again they would swim alongside the schooner quietly, scarcely making a ripple. The boat was sailing very slowly. Lines were gotten out and an effort made to catch some of the tunnies, but without success. A white rag was the only lure offered them.

18. Scomber scombrus Linnæus. *Boston Mackerel.*

Occurs regularly in spring, and is one of the most important species taken in the pound nets at that season. Stragglers occur throughout the summer, and at times good catches have been made in August. Small numbers are sometimes taken in October, as the fish are withdrawing from the coast. In spring they arrive in schools and appear to come from the south, as shown by their capture first in the southernmost pound nets and in the others in regular order. They migrate slowly, both when in large schools and when in small bunches. In good weather they swim at the rate of 6 to 10 miles a day and seem to be leisurely feeding; in stormy weather, however, the runs appear to pass the pound nets more rapidly.

In spring, mackerel and shad are taken at the same time. It often happens that a large run of the two species is coincident. In 1891, in one week, about the 1st of May, 1,500 mackerel were taken in one net in Monmouth County, and during the same time 1,200 shad were caught. Exeptionally large lifts of mackerel are seldom made, for the reason that the schools usually keep well off the shore and the pound nets may be regarded as securing only the stragglers. The largest single catch of mackerel along this shore in recent years was 1,100 fish, caught in the pound net of Mr. Herbert Johnson at Galilee in May, 1891.

The monthly catch of mackerel in one net in 1891 and two nets in 1892, set off the shore of Monmouth County, was as follows:

Months.	1891.	1892.
	Number.	*Number.*
April	4	190
May	1,874	492
June		12
July		2
August	31	14
Total	1,909	710

A great proportion of the mackerel caught are large, weighing 2½ to 3 pounds. They bring good prices in the New York market, to which place nearly the entire catch is shipped. The average wholesale price was about 26 cents in 1891 and 33 cents in 1892.

The testimony of the fishermen as to the spawning condition of the mackerel is unanimously to the effect that the fish are not ripe when they arrive on this coast in spring. While the fish are nearly all shipped round and the fishermen do not have the best opportunities for determining the actual condition of the reproductive organs, the eggs and milt have never been observed to run from the fish when caught or when thrown into the boats; and the fishermen who have at times dressed considerable numbers of the fish state that the ova have always appeared hard and immature.

Opinion is divided as to the probable effect of the resumption of the southern mackerel fishery on the abundance of fish on the New Jersey coast. Some fishermen who have been in the pound-net fishery for many years think that the suspension of the capture of mackerel in the southern waters resulted in an appreciable increase in the supply in New Jersey. They state that ten years ago and prior thereto very few mackerel were caught, and that in the last three or four years there have been more than ever. Others, however, with equal experience, think that the mackerel are no more abundant now than formerly. These divergent views represent the two theories which prevail as to the direction from which the mackerel approach the shores: (1) That there is a coastwise migration and that the fish caught in New Jersey are first found off Cape Hatteras; (2) that the fish come in to shore directly from the ocean and that the littoral movement is only local. Unfortunately, no records are available for early years showing the catch of mackerel in the pound or other nets of this coast.

19. **Scomber colias** Gmelin. *Thimble-eye Mackerel.*

This fish has been exceedingly rare on the New Jersey coast for about six years, prior to which time some very good catches were often made in pound nets. As many as 2,000 or 3,000 pounds have been taken at one lift. The fish usually weighed ¾ or 1 pound, but examples weighing 2 to 3 pounds were also caught. Very few were taken in 1892. The only example observed by the writer was obtained in a pound net near Ocean Grove on September 10. It was 7 inches long. Mr. L. C. Thompson, of Spring Lake, reported that a number were secured in his net at intervals during the summer, and it is probable that stragglers were also taken in other nets.

20. **Selene vomer** (Linnæus).

An example of this fish, 2¼ inches long, was forwarded to the Fish Commission for identification by Mr. O. B. Coit, of Spring Lake, N. J., on August 22, 1892, and was examined by Dr. Tarleton H. Bean. Mr. Coit wrote that the fish was very rare in that locality.

21. **Trachinotus carolinus** (Linnæus). *Pompano.*

Occurs sparingly on the New Jersey coast and every season is taken in small numbers in some of the pound nets. Mr. L. C. Thompson, of Spring Lake, took about 25 pompanos, weighing from ½ to 1½ pounds, in 1892.

22. **Seriola zonata** (Mitchill). *Pilot-fish.*

Occurs irregularly and in small numbers throughout the warmer months. Some 6 to 8 inches long were observed in pound nets in Monmouth County in September. Fish 2 feet in length are sometimes caught. At several places on the New Jersey coast this fish is called "pilot-fish," doubtless because of its resemblance to the species that is properly so called (*Naucrates ductor*).

23. **Seriola dumerili lalandi** (Cuvier & Valenciennes). *Jenny Lind.*

This amber-fish occurs throughout the summer, but is not abundant and is never taken in such numbers in this region as to indicate that it is gregarious. It is called "jenny lind" at several places in the pound-net section. This is the only common name heard for it; its origin could not be ascertained. Numerous examples were observed by the writer in Monmouth County in 1892. Mr. W. H. Gant, of Bradley Beach, has caught specimens that weighed 40 pounds. The usual weight, however, is a pound or a little less, and all the examples seen by the writer were under 2 pounds. In 1891 two fish weighing 10 pounds each were caught in a net near Ocean Grove.

On August 21, 1892, Mr. W. Scott Pierce, of Lake Como, N. J., sent to the U. S. Fish Commission for identification a specimen of this fish which had been taken in a pound net at that place, and stated that it appeared to be new to that part of the coast. A number of these had been caught up to that time.

Mr. Samuel Ludlow, of North Spring Lake, reported a catch of 300 pounds in his pound net in 1892, and it is probable that 5,000 pounds were taken in all the nets in that year.

The fishermen speak of the "genuine butter-fish," which is of a yellow color, is very scarce, and weighs about one-fourth of a pound. It is doubtless a pompano (*Trachinotus*).

27. Centropristis striatus (Linnæus). *Sea Bass.*

This fish is taken in the pound nets early in the season, May being the month in which the largest lifts are made. As the water becomes warmer the fish begins to move offshore; in June the yield is much reduced, and after that time the fish is rarely taken in nets. It approaches the shores again in the cold months, after the nets are taken up, and remains in the inshore waters until the following spring. The sea bass is one of the best fish caught in pound nets early in the season, and the prices received are usually high, often reaching 8 cents a pound and rarely getting below 3 cents.

Next to the bluefish, the sea bass is the most important fish taken in the line fisheries of this coast. Menhaden is the principal bait used by the commercial fishermen, but in sport fishing clams, crabs, and minnows are also employed.

There is a certain relation between the abundance of bluefish and the scarcity of sea bass on this coast. Both species occur at the same season and are taken on the same grounds with the same apparatus. In 1890 bluefish were abundant and sea bass were scarce, more than three-fourths of the catch consisting of the former species; in 1892 there was a scarcity of bluefish and an abundance of sea bass, and in some localities up to the last of August almost the entire catch was sea bass.

The monthly catch of sea bass in one pound net in 1891 and two nets in 1892, set off Monmouth County, was as follows:

Months.	1891 (1 net).	1892 (2 nets).
	Pounds.	*Pounds.*
April	35	50
May	1,443	4,195
June	48	288
July	....	29
Total	1,526	4,562

28. Roccus lineatus (Bloch). *Striped bass; Rockfish; Rock.*

Rarely taken in the pound nets, but common in the bays and rivers, where it is caught with gill nets and seines.

29. Lutjanus blackfordi Goode & Bean. *Red Snapper.*

This fish is casually taken in the pound nets. In 1892 Mr. L. C. Thompson, of Spring Lake, secured four or five weighing about 1½ pounds each. Mr. Thompson had previously caught this fish in Florida and was familiar with it.

30. Archosargus probatocephalus (Walbaum). *Sheepshead.*

A very highly esteemed but not especially abundant species. In the pound nets the largest numbers are taken in June and about the 20th of that month. Very large lifts are rarely made, as the fish do not appear to go in extensive schools. Fifty fish were taken at one lift in June, 1891, at Bradley Beach, which was considered a very large catch, although as many as 150 fish have been occasionally taken. The yield to a net varies from 100 to 1,000 fish annually, 200 or 300 probably being the average. The monthly catch of one net in 1891 and two nets in 1892 was as follows:

Months.	1891.	1892.
	Pounds.	*Pounds.*
June	823	1,122
July	269	773
August	....	364
September	6	....
October	....	184
Total	1,098	2,443

The yield in 1891 in the one net referred to represented 147 fish, with an average weight of 6½ pounds each.

Some years ago the reprehensible practice of killing sheepshead by means of dynamite exploded over sunken wrecks, to which the fish habitually resort, was not uncommon in certain of the bays on the outer shore of New Jersey. The writer saw 33 fish destroyed at one discharge in Great Egg Harbor Bay.

31. **Stenotomus chrysops** (Linnæus). *Porgy.*

Occurs on the shore in considerable numbers between April and July, and is caught in pound nets during that period. The largest quantities are taken in June; in July the fish begin to work off shore, going east, and in the latter part of the summer and in fall only stragglers are taken. The average annual catch to a net is from 1,000 to 2,000 pounds, valued at about 3 cents a pound. The fish weigh from ½ to 2 pounds, the average being about 1 pound.

The following note on the abundance of porgies in 1890 and 1891 has been communicated by Capt. D. T. Church, of Tiverton, R. I.:

> During May, 1890, the largest crop of small scup ever seen on our coast appeared from Barnegat to Hyannis. At the time of their appearance it took 25 fish, by actual count, to weigh a pound; when they left the coast their weight was one-fourth of a pound. On their return in the spring they were about the same size as when they left in the fall. This fall [1891] their weight is half a pound. Probably within a year or so there will be present on the coast the greatest body of scup ever known. When the small scup made their appearance in the spring near Seaconnet a large school of cod was with them. We found them gorged with small scup, one cod examined containing 17 fish. After the cod left squeteague took their place, and their destruction [of scup] was enormous, and it was going on from Sandy Hook to Hyannis.

32. **Cynoscion regalis** (Bloch & Schneider). *Weakfish.*

This is the most abundant and important fish taken in pound nets on the ocean front of New Jersey; next to the bluefish, it is the most valuable species captured on the coast of that State, and, considering the fisheries of the entire State, it is surpassed in importance only by the shad and bluefish.

According to many fishermen, the weakfish was more abundant in 1891 and 1892 than for ten years previously. Notwithstanding the enormous quantities taken, it is not apparent that the supply is being reduced, and some hauls now made are fully as large as any in the history of the fishery. In Monmouth County, during one day in the second week in August, 1891, fully 100,000 pounds of weakfish were caught in one pound net, and 81,800 pounds were taken out and sold. On July 11, 1892, two other nets in the same county yielded 60,000 pounds at one lift, but adjacent nets took only small quantities.

would result in a diminution in the average catch per net. In 1880, when there were 11 pound nets set on this shore, the average stock was somewhat greater than in recent years, although the average quantity of fish taken was a little less. Comparing 1889 with 1892, it appears that, although the number of nets in the latter year was about three times the number in the former, the average catch and stock were greater.

Years.	No. of nets.	Average catch per pound net.	Average stock per net.
		Pounds.	
1880	11	248, 980	$7, 980
1889	8	247, 270	6, 453
1890	7	281, 160	7, 167
1891	12	278, 670	7, 076
1892	23	298, 525	7, 389

The influence of pound nets on the abundance and movements of fishes is a question which can not be answered off hand and which involves a comprehensive knowledge and careful study of the natural conditions determining the migrations and periods of abundance and scarcity of our fishes. Probably the time is not far distant when it will become an obvious necessity in some States to place more stringent regulations on the use of pound and other nets in certain situations, as, for instance, in the mouths of rivers, where the decrease in the catch of shad, sturgeon, salmon, etc., may often be clearly traced to the taking of fish on their way to the spawning-grounds in such numbers that the reproductive process is practically inhibited; but it is a well-recognized fact that pound and other nets which are set in the open waters of the ocean and take chiefly free-swimming marine fishes are the least likely to do serious damage and afford the least ground for apprehension.

Perhaps the most valid and forceful objection that has been made against the pound nets on this coast is that there is a large destruction of immature and small fish that are unmarketable. This criticism is applicable to most of the pound fishing in this country. It is not generally denied by the pound fishermen that many fish too large to go through the meshes of the nets and too small to be marketed are caught and, by the nature of the fishery, necessarily sacrificed. The same objection is justly advanced against much of the seine fishing on our coast. No entirely satisfactory remedy has as yet been suggested for this condition. The enlargement of the mesh in the bowl of the pound nets will not completely overcome present objections and will introduce elements of expense and trouble which the fishermen wish to avoid. The fishermen say that, unless the size of the mesh is made so large that many of the marketable fish will escape, the fish sought to be preserved will be gilled, and thus as effectually destroyed as with a small mesh, while the time and labor required to clear the net of the gilled fish would make the prosecution of the business almost impracticable. The remedy which seems to afford the most relief is to require the pound operators to lift the nets more frequently than is usually done, to liberate all small fish, and bring to the shore only such fish as are marketable. The principal species of which large numbers of small individuals are destroyed on the New Jersey coast is the butter-fish. The fish is naturally a small one, rarely exceeding half a pound in weight and averaging only one-third of a pound. The great relative depth of the body of the fish makes it impossible for even very young to a net varies from 100 to 1,000 fish annually, 200 or 300 probably being the average. The monthly catch of one net in 1891 and two nets in 1892 was as follows:

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The ordinary size of the fish taken in the pound nets is 2 or 3 pounds, the individuals composing the schools usually being of uniform size. Sometimes, though rarely, fish weighing 10 pounds are taken.

Small weakfish under 9 inches in length are called "bay weakfish"; they frequent the bays and are taken in the pound nets only in very small quantities. The principal run begins about July 1 and the fish continue to be caught in large numbers till October 1. They go in schools at all times.

The following statement, giving the catch of weakfish at a pound-net fishery in Monmouth County in 1891 and 1892, shows the monthly fluctuations in the abundance of the fish:

Months.	1891 (1 net).	1892 (2 nets).
	Pounds.	*Pounds.*
April	....	300
May	3,886	2,831
June	31,040	11,644
July	35,680	124,763
August	114,423	200,367
September	34,829	79,863
October	933	69,471
November	....	23,677
Total	220,791	512,916

33. **Cynoscion nebulosus** (Cuvier & Valenciennes).

Not observed. According to the fishermen it is taken in the pound nets only at rare intervals.

34. **Sciæna ocellata** (Linnæus). *Red Drum.*

This fish is in most places considered a nuisance by the pound-net fishermen, and only a very small percentage of the catch is sold, the price received being about 50 cents per fish. Large lifts are made at times. At Spring Lake 250 large drum were caught during one day in 1892, all of which were liberated.

35. **Leiostomus xanthurus** Lacépède. *Spot; Goody; Cape May Goody.*

Not a common fish in the pound nets, but abundant in the bays of this coast, where it is taken with seines and gill nets.

36. **Menticirrhus saxatilis** (Bloch & Schneider). *Kingfish; Barb; Hake.*

In the pound-net fishery this is an uncommon and valued food-fish. It is most abundant in May, when more are taken than in all the other months combined. The average weight of those caught in pound nets is 1¼ pounds. The price received by the net fishermen ranges from 5 to 30 cents each, the average probably being 15 or 20 cents. The general scarcity of the fish is well illustrated by the accompanying statement, showing the monthly catch at a pound-net fishery in Monmouth County:

Months	1891 (1 net).	1892 (2 nets).
	Number.	*Number.*
May	164	101
June	5	2
July	....	....
August	....	2
September	....	25
October	....	14
Total	169	144

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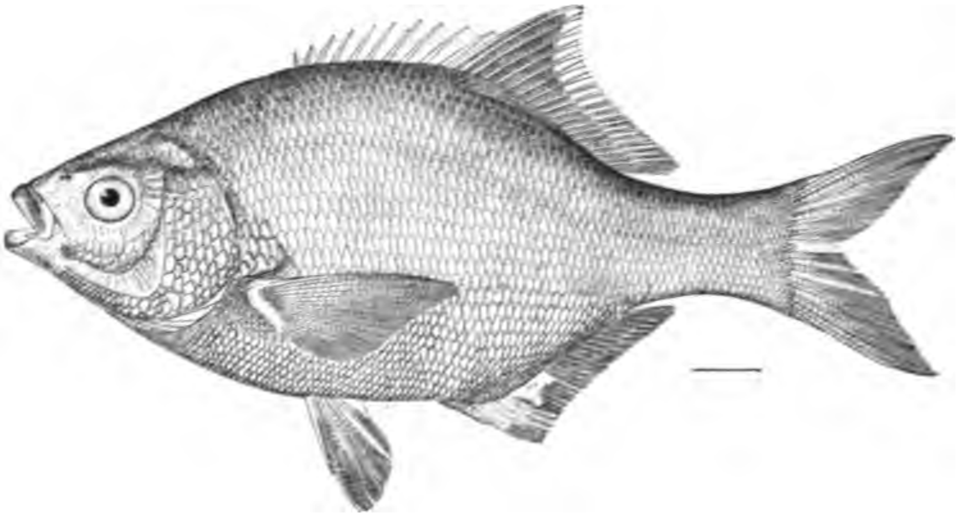
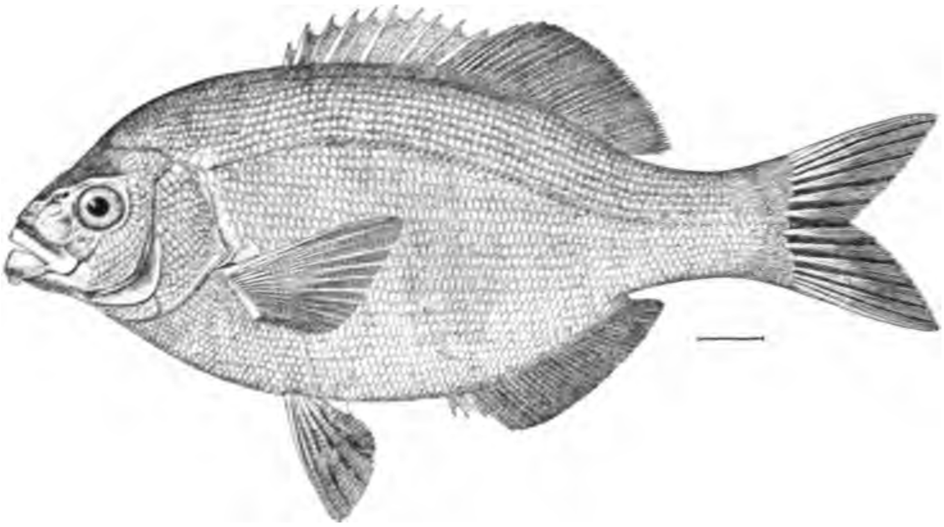
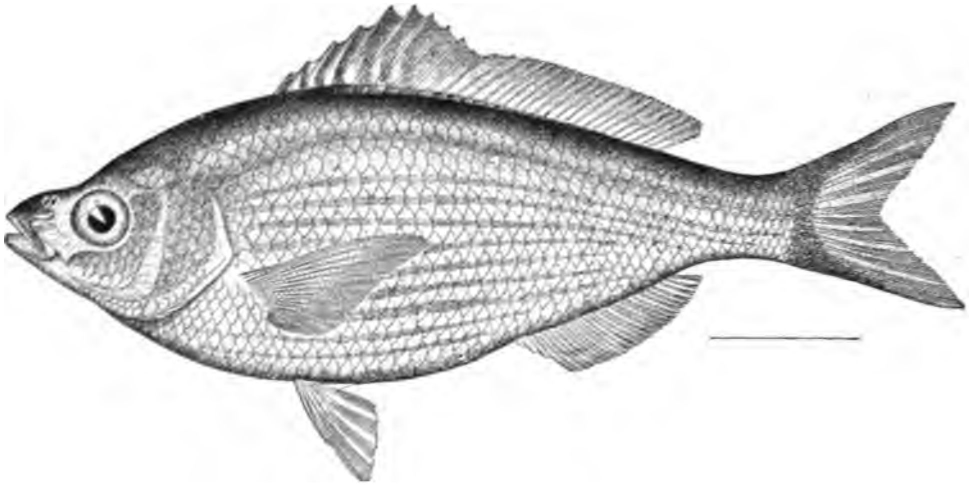


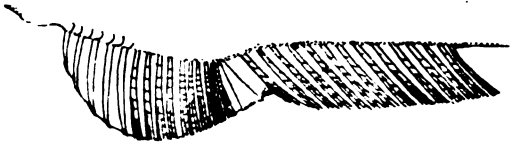
1. DAMALICHTHYS ARGYROSOMUS Girard. **Male.** **Friendly Cove, British Columbia.**



2. RHACOCHILUS TOXOTES Agassiz. **Female.** **Monterey, California.**



3. CYMATOGASTER AGGREGATUS Gibbons. **Female.** **Port Wrangel, Alaska.**



4. ANAL FIN OF THE MALE OF HYPERPROSPON

9.—ON THE VIVIPAROUS FISHES OF THE PACIFIC COAST OF NORTH AMERICA.

BY CARL H. EIGENMANN,
Professor of Zoology, Indiana University.

INTRODUCTION.

During a stay of nearly three years on the coast of California at San Francisco and San Diego, viviparous fishes were daily seen in the markets and a large amount of material illustrating their development was collected. Few adult specimens of *Embiotocidæ* were preserved, since they were already well represented in most museums. The revision of this family is largely based on collections made by Drs. Jordan and Gilbert. Of the *Scorpænidae*, more specimens were collected, since many new forms were discovered. On the other hand, the embryology of this family is of much less interest than that of the *Embiotocidæ*, in which among teleosts viviparity has been carried to the greatest extreme.

The present paper gives a review of the *Embiotocidæ*, a bibliography of the viviparous fishes, and a detailed account, as far as my material permits, of the development of *Cymatogaster* from fertilization to hatching and the details of the development of the intestine and of Kupffer's vesicle. Outlines of the postembryonic development are also presented, but the details of the anatomy of the various postembryonic stages will be reserved for a future paper.

It is the intention of the writer to complete as rapidly as possible the following additional chapters: The development of the skeleton; the circulatory system, and especially the development of the sexual organs from the time of the segregation of the sex cells till sexual maturity (for which practically all the necessary material has been collected); and a revision of the *Scorpænidæ*. Several of these chapters have been sketched out and many of the drawings for them have been prepared.

Points in the embryology of *Cymatogaster*, which, on account of the scarcity of material have not been made out as fully as desired, are, the first formation of the embryo, its relation to the blastopore, and the development from the closing of the blastopore till three protovertebræ are completed. I have given full particulars as to when and where eggs are to be obtained with the hope that others will fill these gaps.

I am indebted to the San Francisco Microscopical Society for the use of its library and for many other courtesies. I am under many obligations to Dr. Theodore Gill, of the Smithsonian Institution. Several years ago he showed me an unpublished and abandoned work on west coast fishes, which, among other things, contained the various accounts of the early observers on the viviparity of *Embiotocidæ*. When, later, I was preparing the historical portion of this paper, Dr. Gill sent me the whole of this material so far as it related to the *Embiotocidæ* as well as all of his manuscript notes, accompanied by the following remarks: "Make such use of them as you wish and keep them as long as you need them. You can use them as copy and thus avoid the task of transcribing."

The synonymy of the *Embiotocidæ* in the following review to 1868 is Dr. Gill's, with only slight alterations. The etymology of the generic names is also reproduced here as given in his unpublished work. Such other portions as I have incorporated in the paper, I have indicated by quotation marks, also giving direct credit for the same.

I wish to express my thanks to Dr. Silas M. Mouser, of San Francisco, in whose laboratory the sections necessary for the part of the work here presented were made. I wish also to acknowledge my indebtedness to ex-Governor (now United States Senator) G. C. Perkins, of San Francisco, for enabling me to visit various parts of the coast of California. I am under similar obligations to Mr. A. N. Towne, of the Southern Pacific Railroad Company. Dr. Howard Ayres kindly furnished me with references to the bibliography bearing on some of the points. Finally, Mrs. Eigenmann assisted me in all the stages of securing and preserving the material, rendered much assistance in preparing the paper, and corrected all the proofs.

A REVIEW OF THE EMBIOTOCIDÆ

[By Carl H. Eigenmann and Albert B. Ulrey.]

The writers have attempted in this paper to collate the various references to the species of *Embiotocidæ* and to present a synopsis of the genera, together with brief descriptions of the species.

Most of the American species have been examined by us, and in order to determine the number of valid genera skeletons have been prepared. These show that the earlier authors have been more fortunate in their opinions concerning genera of *Embiotocidæ* than the more recent ones. The genus *Ditrema* has been admitted on second-hand knowledge. As yet no one has given any very lucid characterization of this genus as distinct from *Embiotoca* and external differences seem to be wanting.

EMBIOTOCIDÆ.

Holconoti or *Embiotocoidæ* Agassiz, Am. Jour. Sci. and Arts (2), v. 16, 383, 1853.
Holconoti seu Embiotocoidæ Troschel, Archiv für Naturgeschichte, 20. Jahrg., B. 1, 167, 1854.
Holconoti or *Embiotocoidæ* Agassiz, Am. Jour. Sci. and Arts (2), v. 17, May, 1854.
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Holconoti Canestrini, Verhandlungen der K. K. Zoölogisch-Botanischen Gesellschaft in Wien, Jahrgang 1860.
Holconotoidei Bleeker, Enum. Sp. Piscium Archipel. Indico, XVIII, 1859.
Holconotidæ Eigenmann, Report State Board Fish Commissioners, California, 1890, 64.
Embiotocidæ Richardson, Encycl. Brit., 8th ed., v. 12, 268, 1856.
Embiotocoidæ Girard, Expl. and Surv. for R. R. Route to Pacific, v. 10, Fishes, 164, 1858.
Embiotocidæ Günther, Cat. Fish. Brit. Mus., v. 4, 244, 1862.
Embiotocoidæ Gill, Proc. Acad. Nat. Sci. Phila. 1862 [v. 14], 274.
Embiotocidæ Cope, Proc. Am. Assoc. Adv. Sci. 1872, v. 20, 343.
Embiotocidæ Jordan & Gilbert, Syn. Fish. N. A., 586, 1883. Jordan, Cat. Fish. N. A., 96, 1885.
Ditremata Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1 Abth., 30, 1872.
Ditremidæ Eigenmann & Eigenmann, Proc. Cal. Acad. Sci. 1890, 2d ser., vol. III, 9.
Menidæ gen., Temm. & Schlegel, Bleeker (1858).
Labroidæ gen., Gibbons, 1854, Van der Hoeven.
Scombridæ gen., Günther, 1860.

Habitat: Coasts of California and Japan, Sacramento Valley.

Description of family of Embiotocidæ.—Viviparous teleosts with united lower pharyngeals; paired nasal openings; dorsal fin single, with 8 to 18 spines; a sheath of scales along the base of part of the dorsal, separated from the scales of the sides by a naked line; anal with three spines, its form differing in the sexes of some species; ventral fins thoracic, I, 5. No teeth on vomer or palatines; teeth in jaws small, some of those on pharyngeals larger, conical or paved. Pseudobranchiæ. No pyloric cœca. Oviduct opening behind the vent.

Common characters.—Body compressed, oblong. Cheeks, operculum, and interoperculum scaly; scales mostly cycloid. Lateral line arched, continuous. Mouth small, terminal; upper jaw protractile. Maxillary without supplemental bone. Gill membranes free from the isthmus.

ANALYSIS OF THE GENERA OF EMBIOTOCIDÆ.

a. Dorsal spines 8–11; anal spines graduated ....(EMBIOTOCINÆ.)

b. Abdominal vertebræ 17; caudal 19; anal basis much shorter than the abdomen; A. III, 23; lips large, lower lip with a frenum; gill-rakers slender, short (7 + 13); anterior and lateral teeth of pharyngeals small, bluntly conic; a triangular posterior patch of larger teeth, all but the posterior row truncate, the posterior row conic. HYPSURUS, 1.

bb. Abdominal vertebræ 13–15; anal basis equaling, or longer than, the abdomen.

c. Teeth entire, usually bluntly conic.

d. Dentiferous surface of lower pharyngeals arched, the anterior teeth much worn, the posterior not at all, the cutting surface of the anterior teeth flattened, that of the posterior teeth not faced. Teeth of the upper pharyngeals similar to those of the lower pharyngeals, but the *posterior* teeth of the upper pharyngeal applied to the *anterior* of the lower pharyngeal; the posterior teeth of the upper pharyngeals thus resemble the anterior of the lower pharyngeals and the anterior of the upper the posterior of the lower ....................................DAMALICHTHYS, 2.

dd. Dentiferous surface of lower pharyngeals flat or concave.

e. Teeth in two series in each jaw. Male with one of the anterior rays of the anal transformed into a triangular plate; anal basis forming a decided angle at this point; the rays in front of this point with a thick covering of skin; pharyngeal teeth mostly small, conic, only a few in the last two series enlarged, some of which are sometimes truncate molars.

f. Vertebræ 33–35; lower lip without a frenum; gill-rakers very long, slender, and tapering, 23 to 29; anal basis below 12–14 caudal vertebræ .........HYPERPROSOPON, 3.

ff. Vertebræ 32 (14 + 18); lower lip without a frenum; gill-rakers moderate, stout, blunt, 6 + 11; anal basis below 11 caudal vertebræ ....HOLCONOTUS, 4.

fff. Vertebræ 29 (13 + 16); lower lip with a broad frenum; gill-rakers short, stout, blunt, 5 + 11; anal basis below 10 caudal vertebræ.................AMPHISTICHUS, 5.

ee. Teeth none, or in a single series in each jaw, anterior and lateral pharyngeal teeth small, conic, the median and posterior ones large, truncate, molars; males with a gland on some of the anterior anal rays, the anal basis without angle, none of the rays modified to form a definite plate.

g. Teeth none, lips thin; jaws greatly protractile ....NEODITREMA, 7.

gg. Teeth in both jaws.

h. Lower lip very thick, lobed, without a frenum; gill-rakers long....RHACOCHILUS, 6.

hh. Lower lip thin, normal, entire, with a frenum.

i. Scales small, 60–75 in lateral line.

j. The characters of *Ditrema* should be added here. No examination of internal organs has as yet been made ....DITREMA, 8.

k. Vertebræ 14 + 18 or 19, anal basis below 9 caudal vertebræ; first hæmal spine small, applied to the second.................................EMBIOTOCA, 9.

kk. Vertebræ 14 or 15 + 21 to 24; anal basis below 11 or more caudal vertebræ; first hæmal spine as large as second, sometimes approximated with the second.
Phanerodon, 10.

ii. Scales large, 40-50 in lateral line; vertebræ 13 + 21 or 15 + 19; gill-rakers short, blunt, wide set, 6 + 12; anal basis (*rosaceus*) below 9 caudal vertebræ.
Brachyistius, 11.

hhh. Lower lip thin, without a frenum; vertebræ, 14+20; scales large, less than 40 in lateral line; gill-rakers long, slender, 10+21; anal basis below 12 caudal vertebræ; pharyngeal teeth as in *Brachyistius*, the central and posterior ones blunt molars...Cymatogaster, 12.

cc. Teeth incisor-like, trilobed; vertebræ, 14+20; scales, large; outer series of pharyngeal teeth small, conic; the rest (about 32) large molars closely appressed; anal basis below 7 caudal vertebræ; gill-rakers long, slender, 6+14; sixth dorsal spine highest; male with a deep depression at the base of the anterior anal rays, a gland below the middle of the depression.......................................Abeona, 13.

aa. Dorsal spines 16-18, the sixth or seventh highest; second anal spine largest; vertebræ, 14+20; about 12 of the median posterior teeth of pharyngeals large, all but the median three of these obliquely truncate molars, the remainder small; gill-rakers short, slender, 6+12; teeth in a single series; lower lip without frenum.
(*Hysterocarpinae*), Hysterocarpus, 14.

1. HYPSURUS[*] A. Agassiz.

Embiotoca sp. Agassiz, Am. Journ. Sci. & Art, 1853, 389 (sp.).
Hypsurus A. Agassiz, Proc. Bost. Soc. Nat. Hist. 1861, 133 (*caryi*).

Type: *Embiotoca caryi* L. Agassiz.

1. HYPSURUS CARYI Agassiz.

Embiotoca caryi Agassiz, Am. Journ. Sci. & Art (2), v. 16, 389, 1853 (San Francisco); Agassiz, Am. Journ. Sci. & Art (2), v. 17, 366, 1854; *id.*, Archiv für Naturgeschichte, 21. Jahrg., B. 1, 32, 1855; A. Agassiz, Proc. Bost. Soc. Nat. Hist., v. 8, 126, 1861.

Hypsurus caryi A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 133, 1861; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to Santa Barbara, Cal.); Rosa Smith, A List of the Fishes of San Diego, Cal., Nov., 1880; Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, San Francisco, Santa Barbara, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 11 (Tomales to Santa Barbara, Cal.); Jordan & Gilbert, Syn. Fish. N. A., 593, 1883 (Santa Barbara to San Francisco); Jordan, Cat. Fish. N. A., 96, 1885; E. & E., Annals N. Y. Acad. Sci., VI, June, 1892 (Santa Barbara to San Francisco).

Ditrema caryi Günther, Cat. Fish. Brit. Mus., IV, 247, 1862 (San Francisco).

Holconotus gibbonsii, Cal. Acad. Sci., MSS., 1854; Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 122; Archiv für Naturg., 21. Jahrg., B. 1, 333, 1855.

Habitat: Coast of California from San Diego to San Francisco. This species is but rarely found at San Diego, only one or two specimens having been seen there. It is, however, one of the commonest species of *Embiotocidæ* in the San Francisco markets.

Body elliptical, ventral profile much straighter than dorsal; caudal peduncle slender, head considerably depressed above the eye; lower jaw included; rays of dorsal fin equaling or higher than spines. The maxillary reaches about eight-ninths distance to front of orbit, included under the orbital; premaxillaries anteriorly about on a level with lower rim of pupil. The anal fin very short, placed far back, the rays closely crowded together and spines small; fourth to sixth dorsal spines highest.

Head, 3½; depth, 2½; D. X, 23; A. III, 24; Lat. line, 71.

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[*] Ὕψι, high, and οὐρά, tail.

2. DAMALICHTHYS* Girard.

Damalichthys Girard, Proc. Acad. Nat. Sci. Phila. 1855, 321 (*vacca*); *id.* Pacific R. R. Survey, x, 181, 1859; Gill, Proc. Acad. Nat. Sci. Phila. 1855, 321; Jordan & Gilbert, Syn. Fish. N. Am., 597, 1883.

Embiotoca Girard, Proc. Acad. Nat. Sci. Phila. 1855, 136 (sp.).

Ditrema Günther, Cat. Fish. Brit. Mus., IV, 1862 (sp.).

Type: *Damalichthys vacca* Girard=*argyrosomus.*

2. DAMALICHTHYS ARGYROSOMUS Girard.

(Plate XCII, fig. 1.)

Embiotoca argyrosomus Girard, Proc. Acad. Nat Sci. Phila. 1855, VII, 136 (San Francisco); *id.* Pacific R. R. Survey, VI, 25, 1857; *id.* Pacific R. R. Survey, x, 180, 1859 (San Francisco); A. Agassiz, Proc. Boston Soc. Nat. Hist., VIII, 127, 1861; Cooper, Nat. Wealth Cal. by Cronise, 489.

Phanerodon argyrosoma Gill, Proc. Acad. Nat. Sci. Phila., v. 14, 274 (note).

Damalichthys argyrosomus Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Puget Sound to San Pedro, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Puget Sound, Monterey, Santa Barbara, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 49 (San Pedro to Puget Sound); Bean, Proc. U. S. N. M. 1881, 265 (Puget Sound, Vancouver Island); Bean, Proc. U. S. N. M. 1883, 360 (Departure Bay, B. C.); Jordan & Gilbert, Syn. Fish. N. A., 597, 1883 (Pacific coast north to Vancouver Island); Jordan, Cat. Fish. N. A., 97, 1885 (name); Eigenmann & Eigenmann, Proc. Cal. Acad. Sci., 2d ser., vol. III, 9, 1890 (San Diego); *id.* Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego, San Pedro to San Francisco, Puget Sound).

Damalichthys vacca Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 321, 1855 (Puget Sound); Archiv für Naturgeschichte, 21. Jahrg., B. 1, 318, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 182, pl. XXXIII, 1858; Suckley, Expl. and Surv. for R. R. Route to Pac., v. 12, Stevens' Report, book 2, 358, 1859; Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 127, 1861; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Lockington, Rpt. Comm. Fisheries California, 30, 1879.

Ditrema vacca Günther, Cat. Fish. Brit. Mus., IV, 246, 1862 (San Francisco).

Habitat: Pacific coast, from San Diego to Vancouver Island.

This species is not uncommon at San Diego and is quite abundant in the San Francisco markets.

Body ovate, dorsal and ventral profile nearly equally curved, tapering abruptly into a long slender caudal peduncle. Head rather large, occipital region little depressed; lower jaw included; maxillary reaching nearly to the front of the orbit. Eye large, a little longer than the snout. Teeth few, conical, bluntish, in one series. Gill-rakers slender, 7+13. Spines of dorsal fin stout, shorter than longest rays. Pectorals long, reaching beyond the ventrals. Color soiled white, with silvery luster; three or four obscure dusky bars, most distinct in the young: fins nearly plain, dusky.

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* δάμαλις, calf; ἰχθύς, fish, in allusion to its viviparity.

3. HYPERPROSOPON[*] Gibbons.

Hyperprosopon Gibbons, Daily Placer Times and Transcript, May 18, 1854; Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 124 (*argenteus*); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 132, 1861.
Ennichthys[†] Girard, Proc. Acad. Nat. Sci. Phila. 1855, v. 7, 322 (*megalops*).
Hyperprosodon[‡] Troschel, Archiv f. Naturg., 21. Jahrg., Band 1, 338–344.
Bramopsis[§] Agassiz, MSS. (fide A. Agassiz) (*mento*).
Hypocritichthys[‖] Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 275 (*analis*).
Amphistichus Jordan & Gilbert, Syn. Fish. N. Am., 590, 1883 (sp.).
Holconotus Jordan, Cat. Fish. N. Am., 96, 1885 (sp.).

Type: *Hyperprosopon argenteus* Gibbons.

We have not been able to examine *H. analis* A. Agassiz, which may constitute a genus distinct from *Hyperprosopon*. The latter is distinguished from *Holconotus* by the characters indicated in the key to the genera.[**]

ANALYSIS OF SPECIES OF HYPERPROSOPON.

a. Anal fin, III, 23. (*Hypocritichthys* Gill.)
  b. Body comparatively elongate; upper anterior profile nearly straight, depressed above the eyes. Snout sharp. Mouth large, very oblique, the tip of the lower jaw on a line with the upper profile of the snout; maxillary reaching front of orbit. Dorsal spines high and slender, longer than the soft rays, the middle longest; anal spines small; caudal fin short, not widely forked; pectorals short and broad, four-fifths the length of head. Eye, five-fourths the length of snout; Head, 3⅓; depth, 2⅓; D. IX, 22; A. III, 23; lat. l., 63. Color silvery; an inky blotch on the middle of the anal, and a fainter blotch on the spinous dorsal; front of anal yellow; fins otherwise plain. Axil black. (Jordan & Gilbert.) .... ANALIS, 3.
aa. Anal fin, III, 29–32. Interorbital region rather abruptly depressed at the nape. Eye large. (*Hyperprosopon* Gibbons.)
  c. Ventral fins broadly tipped with black; anal plain or with dusky margin, III, 33; D. IX, 27; lat. l., 72–74. Eye, 3. Body ovate, the ventral profile somewhat more curved than the dorsal. Snout very short, considerably shorter than the eye. Maxillary not included under the orbital, reaching almost to the front of the orbit; mouth oblique, the lower jaw projecting. Dorsal fin with middle spines higher than the last or than the soft rays; anal low, spines slender. Head, 3⅓; depth, 2. "Color, bluish black above; sides bright silvery, sometimes faintly barred." .... ARGENTEUS, 4.
  cc. Ventral fins plain; anal blackish anteriorly, III, 30; D. IX, 25; lat. l., 60–65. Eye, 3¼. Body elliptic ovate, the dorsal outline not curved as much as the ventral; snout very short, much shorter than the eye; maxillary not included under the orbital, reaching nearly to the front of the orbit; mouth oblique, the lower jaw projecting. Sixth dorsal spine highest, higher than the soft rays; anal low, the spines weak. Head, 3⅓; depth, 2. Color, "greenish olive above, sides bright silvery; 5 or 6 short blackish vertical bars on the sides, these sometimes obsolete; caudal reddish, dusky at tip." .... AGASSIZII, 5.

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[*] *Hyperprosopon:* Ὑπέρ, above, and πρόσωπον, face; alluding to the production upward of the facial outline and snout.

[†] *Ennichthys:* Contracted from Ἐννεοσσεύω, to hatch, and ἰχθύς, fish; in allusion to the viviparity.

[‡] *Hyperprosodon:* Probably due to a misapprehension of the etymology of *Hyperprosopon*, and perhaps supposed to have been derived from ὑπέρ, quasi, excessively, and πρόσοδος, sexual intercourse.

[§] *Bramopsis: Brama*, type of a peculiar family of Acanthopterygian fishes, and οψις, form; in allusion to a superficial resemblance of the genus to *Brama*.

[‖] *Hypocritichthys:* Ὑποκρίτής, hypocrite, and ἰχθύς, fish; alluding to the deceptive nature of the external appearance, the genus having much superficial resemblance to *Cymatogaster* in form as well as size, disguising in a measure its close affinity to *Hyperprosopon*. Type, *H. analis*.

[**] Dr. Gill informs us that on the basis of the classification adopted the genus *Hypocritichthys* is valid and distinct from *Hyperprosopon*.

3. HYPERPROSOPON ANALIS A. Agassiz.

Hyperprosopon analis A. Agassiz, Proc. Boston Soc. Nat. Hist., VIII, 133, 1861 (name only); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (Port Harford and Monterey).

Hypocritichthys analis Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 275 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868.

Ditrema anale Günther, Cat. Fish. Brit. Mus., IV, 250, 1862 (California).

Holconotus analis Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Monterey Bay, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 51 (San Francisco to San Luis Obispo, California); Jordan, Cat. Fish. N. Am., 996, 1885.

Amphistichus analis, Jordan & Gilbert, Syn. Fish. N. Am., 591, 1883.

Habitat: Port Harford to San Francisco. Rare.

4. HYPERPROSOPON ARGENTEUS Gibbons.

Hyperprosopon argenteum Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 105 (San Francisco); l. c. 125; *id.*, Archiv. für. Naturg., 21. Jahrg., B. 1, 338, 1855; A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 132, 1861; Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 276 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego, San Pedro to San Francisco).

Holconotus argenteus Rosa Smith, A List of the Fishes of San Diego, California, 1880, Nov.; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, California); Jordan, Proc. U. S. N. M. 1881, 10 (Monterey, San Francisco, Santa Barbara, and San Diego, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to San Diego, California); Rosa Smith, West Am Scientist, 1885, June; Jordan, Cat. Fish. N. A., 96, 1885 (name).

Hyperprosopon argenteum punctatum Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 106 (fide Gill).

Hyperprosopon arcuatus Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 125; Archiv. f. Naturg. 1855, B. 1, 339; Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 275 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, California).

Ditrema arcuatum Günther, Cat. Fish. Brit. Mus., IV, 249, 1862 (San Francisco).

Amphistichus arcuatus Jordan & Gilbert, Syn. Fish. N. A., 591, 1885 (Cape Mendocino and southward).

Holconotus megalops Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 152.

Ennichthys megalops Girard, l. c., 323; Archiv. f. Naturg. 1855, B. 1, 351; Girard, Pacific R. R. Survey, v. 6, 26; *id.*, l. c., v. 10, 197, pl. XXXVII and XXVI, fig. 10 (Presidio, Humboldt Bay, Astoria).

Ditrema megalops Günther, Cat. Fish. Brit. Mus., IV, 249, 1862.

Habitat: Astoria to Ensenada.

5. HYPERPROSOPON AGASSIZI Gill.

Hyperprosopon arcuatum A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 133, 1861 (not of Gibbons).

Hyperprosopon agassizi Gill, Proc. Acad. Nat. Sci. Phila., v. 14, 276, 1862 (California); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (Santa Barbara to San Francisco).

Ditrema agassizi Günther, Cat. Fish. Brit. Mus., IV, 250, 1862 (San Francisco).

Holconotus agassizi Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to Santa Barbara, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey and San Francisco, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to Santa Barbara, Cal.); Jordan, Cat. Fish. N. Am., 96, 1885 (name only).

Amphistichus agassizi Jordan & Gilbert, Syn. Fish. N. A., 592, 1883 (California).

Hyperprosopon punctatum Cooper, Nat. Wealth Cal. by Cronise, 486, 1868.

Habitat: Santa Barbara to San Francisco.

4. **HOLCONOTUS**[*] Agassiz.

Holconotus Agassiz, Am. Journ. Science and Art, v. 17, 367, May, 1854 (*rhodoterus*).
Cymatogaster Gibbons, Daily Placer Times and Transcript, June 21, 1854 (not *Cymatogaster*, l. c., May 18, 1854); Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 123.

As here understood, this genus is composed of but a single species.

6. **HOLCONOTUS RHODOTERUS** Agassiz.

Holconotus rhodoterus Agassiz, l. c. (San Francisco); Archiv. f. Naturg. 1855, B. 1, 34; A. Agassiz, Proc. Boston Soc. Nat. Hist., vol. 8, 132, 1861; Cooper, in Cronise Nat. Wealth Cal., 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to Santa Barbara); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, San Francisco and Santa Barbara); Jordan & Gilbert, Proc. U. S. N. M. 1880, 50 (Tomales to Santa Barbara, California); Jordan Cat. Fish. N. A., 96, 1885; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., June, 1892 (San Diego, Santa Barbara, Monterey, San Francisco).
Ditrema rhodoterum Günther, Cat. Fish. Brit. Mus., IV, 250, 1862 (San Francisco).
Amphistichus rhodoterus Jordan & Gilbert, Syn. Fish. N. A., 592, 1883 (California); Eigenmann & Eigenmann, Proc. Cal. Acad. Sci., 2d ser., III, 9, 1890 (San Diego).
Cymatogaster pulchellus Gibbons, Proc. Acad. Nat. Sci. Phila., v. 8, 123, July, 1854; Archiv für Naturg., 21. Jahrg., B. 1, 335, 1855.
Holconotus pulchellus A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 132, 1862; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868.
Cymatogaster larkinsii Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, 123 (San Francisco); Archiv f. Naturg. 1855, B. 1, 335.
Cymatogaster ellipticus Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, 124 (San Francisco); Archiv f. Naturg. 1855, B. 1, 336.

Habitat: Coast of California from San Francisco to San Diego.

Body ovate, dorsal and ventral outlines nearly equally curved. Profile above the eye little depressed; the snout a little longer than the eye. Mouth quite oblique, the lower jaw not projecting; maxillary not included under the orbital, reaching to the front of the pupil. Fifth dorsal spine highest, considerably higher than the soft rays; pectorals falcate, not reaching the tips of ventrals; color, "greenish above; sides silvery, profusely covered with spots and blotches of light orange-brown or coppery red, these mostly in the form of interrupted vertical bars; caudal, anal, and ventral fins bright reddish without black spots or markings" (Jordan & Gilbert). Head, 3½; depth, 2¼. D. IX or X, 26; A. III, 29; Lat. line, 69.

5. **AMPHISTICHUS** Agassiz.

Amphistichus[†] Agassiz, Am. Journ. Science and Art, (2) v. 17, 367, May, 1854 (*argenteus*).
Mytilophagus[‡] Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, 125 (*fasciatus=argenteus*).

Type: *Amphistichus argenteus* Agassiz.

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[*] 'Ολκός, furrow, and *νῶτος*, back; referring to the dorsal furrows common to all the species of the family.

[†] *Amphistichus:* 'Αμφί, used in the sense of double, and *στοίχος*, rows; referring to the two rows of teeth in each jaw.

[‡] *Mytilophagus:* Μυτῖλος, *Mytilus*, and *φαγεῖν*, to eat; in allusion to the supposed principal food of the genus.

7. AMPHISTICHUS ARGENTEUS Agassiz.

Amphistichus argenteus Agassiz, Am. Journ. Science and Arts (2), v. 17, 367, 1854 (California); Archiv für Naturg. 1855, B. 1, 34; Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 141 and 153; *id.*, l. c., 323; *id.*, Archiv. f. Naturg. 1855, B. 1, 352; *id.*, Pacific R. R. Survey, v. 10, 201, pl. xxxix, 1859 (San Francisco, Presidio); *id.*, l. c., Whipple's Report. 51, 1859 (San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco); Agassiz, Proc. Boston Soc. Nat. Hist. 1861, 131; Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275 (California); Cooper, in Cronise Nat. Wealth Cal., 489, 1868; Rosa Smith, A List of the Fishes of San Diego, Cal., Nov., 1880; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, San Francisco, Santa Barbara, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to San Diego, Cal.); Jordan & Gilbert, Syn. Fish. N. A., 593, 1883 (California); Jordan, Cat. Fish. N. Am., 96, 1885; Rosa Smith, West Am. Scientist, June, 1885 (San Diego); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., vi, June, 1892 (San Diego to San Francisco).

Ditrema argenteum Günther, Cat. Fish. Brit. Mus., iv, 251, 1862 (San Francisco); Lord, Naturalist in Vancouver Isl. and Brit. Col., i, 120, pl. opposite p. 160, 1866.

Mytilophagus fasciatus Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 125 (San Francisco); *id.*, Archiv f. Naturg., 1855, B. 1, 340.

Amphistichus heermanni Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 135.

Ennichthys heermanni Girard, l. c., 323; *id.*, Archiv f. Naturgeschichte, 1855, B. 1., 351; *id.*, Pacific R. R. Survey, v. 10, 199, pl. xxxviii and xxvi, fig. 9, 1859 (Cape Flattery, San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco).

Amphistichus similis Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 153; *id.*, l. c., 323, 1855; *id.*, Archiv f. Naturg. 1855, B. 1, 353; *id.*, Pacific R. R. Survey, 203, pl. xxxvi, fig. 5–9, 1859 (San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco).

Habitat: San Diego to Cape Flattery.

Body ovate, the dorsal profile much more curved than the straightish ventral outline. Mouth slightly oblique, comparatively large. Snout longer than the rather small eye. Interorbital region little depressed; maxillaries not included under the orbital, reaching to the front of the pupil; lower jaw included. Dorsal spines strong, the fifth or sixth longest, not so long as the soft rays; pectorals slightly falcate, reaching almost to the tips of the ventrals. Head, 3½; depth, 2¼; D. x, 24; A. iii, 26; lat. l., 67. Color, "silvery; sides with narrow vertical bars of a brassy olive color, alternating with vertical series of spots of similar color; fins plain; vertical fins sometimes edged with dusky." A few specimens have been observed in which the sides were uniformly brassy.

6. RHACOCHILUS Agassiz.

*Rhacochilus** Agassiz, Am. Journ. Science and Art, (2) v. 17, 367, May, 1854 (*toxotes*).

Pachylabrus† Gibbons, Proc. Cal. Acad. Sci. in Daily Placer Times and Transcript, San Francisco, June 21, 1854.

Type: *Rhacochilus toxotes* Agassiz.

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* *Rhacochilus:* Ράκος rag, and χεῖλος, lip; referring to the slashed lips of the adult.

† *Pachylabrus:* Παχύς, thick and *labrus*, lip; a hybrid word alluding to the thickened lips.

8. RHACOCHILUS TOXOTES Agassiz.

(Plate XCII, fig. 2.)

Rhacochilus toxotes Agassiz, Am. Journ. Sci. and Art (2), v. 17, 367, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 33; Girard, Proc. Acad. Nat. Sci. Phila., v. 8, 136, 1856; Girard, Expl. and Surv. for R. R. Route to Pacific, v. 10, Fishes, 188, pl. XL, 1859 (Tomales Bay); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 130, 1861; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Pedro, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, Wilmington, Santa Barbara, San Francisco, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 49 (San Pedro to San Francisco, California); Eigenmann, 1890; Jordan & Gilbert, Syn. Fish. N. A., 596, 1883 (California); Jordan, Cat. Fish. N. Am., 96, 1885; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to San Francisco).

Ditrema toxotes Günther, Cat. Fish. Brit. Mus., IV, 247, 1862 (San Francisco).

Pachylabrus variegatus Gibbons, Proc. Acad. Nat. Sci. Phila., v. 7, p. 126; Archiv für Naturgeschichte, 21 Jahrg., B. 1, p. 311, 1855.

Habitat: San Francisco to San Diego.

Body ovate, tapering abruptly into a long and robust caudal peduncle; mouth comparatively large, the lower jaw included; eye large; the soft dorsal rays considerably higher than the low spinous dorsal; caudal short, deeply forked, the upper lobe the longer; pectorals and ventrals long. Head, 3⅖; depth, 2⅖; D. X, 23; A. III, 30; lat. line, 76. Color olivaceous with brassy reflections and dusky points; fins plain.

7. NEODITREMA Steindachner & Döderlein.

Neoditrema Steindachner & Döderlein, Denk. Ak. Wiss. Wien, XLVII 32, 1883 (*ransonneti*).

Type: *Neoditrema ransonneti* St. & D.

This genus is described as a *Ditrema* without teeth in its jaws.

9. NEODITREMA RANSONNETI Steindachner & Döderlein.

Neoditrema ransonneti Steindachner & Döderlein (Yokohama, Tokio).

Habitat: Japan.

Strongly compressed, especially below the pectorals; profile to occipital process concave; mouth greatly protractile; head pointed, mouth oblique; lower jaw included; maxillaries concealed under preorbital, reaching to eye. Dorsal spines graduated from the first to the last, which is equal to the snout and half the eye in length; caudal widely forked, about equal to the head exclusive of snout. Back dusky, golden yellow below lateral line; base and tip of caudal dusky, remainder of fin yellow. Head, 3⅔ to 3¾; depth, 3⅓; D. VI–VIII, 21 or 22; A. III, 26–27. Lat. l., 70. Br., 5. (Steindachner.)

8. DITREMA* Schlegel.

Ditrema Schlegel, Fauna Japonica, 77, pl. XL, fig. 2.

Ditrema Bleeker, Verh. Batav. Genootsch, XXV, 33 (*temminckii*).

Ditrema Brevoort, Narrative U. S. Exped. to Japan (Perry's), II, 265, 1856 (first referred to the family *Embiotocidæ*).

Ditrema Günther, Cat. Fish Brit. Mus., IV, 244, 1862 (=*Embiotocidæ*).

Ditrema Jordan & Gilbert, Syn. Fish N. A., 594, 1883 (=several genera).

Type: *Ditrema temminckii* Bleeker.

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* *Ditrema:* Δις, double, and τρῆμα, hole; referring to the presence of the special generative aperture in addition to the anal one.

10. DITREMA TEMMINCKII Bleeker.

Ditrema, Schlegel, l. c. (abundant in spring in Bay of Nagasaki); Gill, Proc. Phil. Acad. Sci. 1862, 126.

Ditrema temminckii Bleeker, l. c.; Brevort, l. c. (Hakodadi, in latitude 41° 49′ N.); Günther, Cat. Fish. Brit. Mus., IV, 246, 1862 (Japan); Bleeker, "Notices Ichthyologiques No. X."; Putnam, "Bull. Mus. Comp. Zool."; Nyström, Sv. Ak. Hand., XIII, afd. 4, No. 4, p. 32 (Japan).

Ditrema læve Günther, Cat. Fish. Brit. Mus., II, 392, 1860 (Japan.)

Habitat: Japan.

Brevoort says, l. c.:

> The genus *Ditrema* was established by Schlegel upon examination of two stuffed specimens and a native figure of a fish which offered the peculiarity of two anal orifices. * * * He gave the fish no specific name. * * * The figure by the artists of the United States Japan Expedition is identical with the one in the Fauna Japonica, though rather darker in coloring. It does not show the specific characters distinctly. * * * Upon showing the published figure of the *Ditrema*, and the figure of it by the American artist, to Diengkitch, he immediately described its viviparous faculty. * * * In the list of fishes * * * is one called in Chinese *Ju* or *Lian*, in Japanese *Tanako*, "a fish which swims in pairs"; and in a footnote Mons. A. Remusat (Notices et Extraits des Manuscrits, tome XI, part 1, 1827, p. 216) says: "It is asserted that this fish is viviparous * * *." This very interesting note, the authority for which is not given, induced me to compare the *Ditrema* with a specimen of the California viviparous fish procured by Dr. John LeConte in that country in 1851, and with the descriptions of the *Embiotocidæ* and *Holconoti*, by Agassiz * * * "when no doubt remained on my mind that species of the same family of fish were thus proved to occur on the Asiatic coast of the Pacific also.

11. DITREMA SMITTII Nyström.

Ditrema smittii Nyström, Sv. Ak. Handl., XIII, 4, afd. No. 4, p. 32, 1887 (Japan).

We add here the original description, a copy of which has been furnished by Dr. Theo. Gill:

No. 86. Ditrema smitti* n. sp.

Diagn.—Kroppens höjd ungefär ⅓ af totallängden; bakre delen af analfenan betydligt högre än den främre, och 17:de—20:del strålarne tradformigt förlängda; brostfenornas spetsar nä till analfenans början.

R. f.11+21. A. f. 3+27. Br. f. 17. L. lat. 78. l. tr. $\frac{11}{8}$.

Kroppsformen är något mera långstrackt än hos föregående, med hvilken denna art för öfrigt synes visa närmaste slägtskapen, och största kroppshöjden utgör ungefär ⅓, och hufvudets längd ¼ af total-längden. Ögats diameter innehålles i det närmaste 4 ggr., och nosens längd, som är lika med pannans bredd mellan ögonen, 3⅓ ggr. i hufvudets längd.

Nosen öfre profilkontur är svagt konvex, och mellan ögonen är en framskj utande knöl, bakom hvilken pannan åter är något intryckt. Bakre delen af hufvudet är mera konvex och starkare uppstigande, dock ej så mycket som hos föregånde art. Ryggen år temligen jåmnt böjd till slutet af ryggfenan, och afståndet från basen af den sista ledade strålen till spetsen af stjärtfenans öfre flik är något större än hos D. laeve, och lika med afståndet från nosspetsen till bukfenornas rot.

Främre afdelningen af ryggfenan är läg och taggsträlarne tilltaga successivt i längd bakåt; den sista är dock något lägre än den första ledade strålen, och dess längd uppnår ungefäar ⅓ af hufvudets. Den mjukstråliga delen af ryggfenan är temligen jämnt afrundad, och de mellersta strålarne, som äro de längsta, innehållas omkring 2ggr. i hufvudets längd.

Analfenan har den bakre afdelingen, från med den 16:de strålen, betydligt högre ån den främre, och öfvergången mellan de båda afdelnidgarne sker hastigt, så att den 16: de strålen är i det närmaste dubbelts å lång som den före gående. 17:de—20:de fenstrålarne äro trådformigt förlängda, och af dessa äro de båda mellersta längst och ungefär lika långa som bröstfenorna.

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* Arten är uppkallad after en af gifrarne, Herr J. C. Smitt i Japan.

Dessa äro spetsiga och temligen långa, ungefär ⅔ af hufvudets längd, och deras bakåtlagda spetsar nå till analfenans början; bukfenorna äro betydligt kortare och innehålla 2 ggr. i hufvudet.

Öfre kanten af ryggfenans taggstråliga del svart, och vid basen af den mjukstråliga en smal linie af samma färg. Bröstfenorna gulaktiga, bukfenorna i spetsen svarta, den första strålen hvit med en svart fläck vid basen. Praeoperculum har strax bakom underkäkens ledgång en temligen liten, svart fläck och bakom denna en något större af samma färg.

Endast ett exempl, l. 18 cm.

9. **EMBIOTOCA*** Agassiz.

Embiotoca Agassiz, Amer. Journ. Science and Art (2), v. 16, 386, Nov., 1853.

Embiotoca Agassiz, Amer. Journ. Science and Art, v. 17, 366, May, 1854.

Holconotus† Gibbons, Proc. Acad. Nat. Sci. Phila., v. 7, 122, July, 1854 (*Agassizii* = *lateralis*).

Embiotoca Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 320, Apr. 1855; v. 8, p. 136 (sine desc.), 1856.

Embiotoca A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 126 (133), 1861.

Ditrema Günther, 1862 (sp.).

Ditrema Jordan & Gilbert, 1883 (sp.).

Type: *Embiotoca jacksoni* Agassiz.

12. **EMBIOTOCA JACKSONI** Agassiz.

Embiotoca jacksoni Agassiz, Am. Journ. Sci. and Art (2), v. 16, 387, 1853; Archiv für Naturgeschichte, 20. Jahrg., B. 1, 157, 1854; Agassiz, Am. Journ. Sci. and Art (2), v. 17, 366, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 32, 1855; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 151, 1854; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 320, 1855; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 345, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 168, pl. XXVII, XXVIII, and XXVI, f. 3 and 4, 1855 (Tomales Bay, San Francisco); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 126, 1862; Gill, Proc. Acad. Nat. Sci. Phila. [v. 14], 275, 1862 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Rosa Smith, A List of the Fishes of San Diego, Cal., 1880, Nov.; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, Cal.); E. & E., Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to Puget Sound).

Ditrema jacksoni Günther, Cat. Fish. Brit. Mus., IV, 245, 1862 (San Francisco); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Puget Sound to San Diego, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, San Francisco, Santa Barbara, Wilmington, Santa Catalina Island, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Puget Sound to San Diego, Cal.); Bean, Proc. U. S. N. M. 1881, 265 (Puget Sound); Jordan & Gilbert, Syn. Fish. N. Am., 595, 1883 (Pacific Coast U. S.); Jordan, Cat. Fish. N. Am., 96, 1885; Rosa Smith, West Am. Scientist, June, 1885; Eigenmann, Am. Nat., March, 1889 (Development).

Holconotus fuliginosus Gibbons, Proc. Acad. Nat. Sci. Phila., y. 7, 123, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, p. 334.

Embiotoca cassidyi Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 151, 1854; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 320; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 346, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 171, pls. XXIX and XXVI, f. 12, 1859 (San Diego).

Embiotoca webbi Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 320, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 346, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 173, pl. XXX, 1859 (San Diego).

Habitat: San Diego to Puget Sound.

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* *Embiotoca:* 'Εμβίος, living, and τόκος, bringing forth; having reference to the viviparity which the species of the genus share with all the other members of the family.

† The name *Holconotus* was invented by Gibbons independently, and is not synonymous with the *Holconotus* of Agassiz.

Body ovate, rather thick, the outlines nearly equally convex; snout blunt and rounded, as long as the eye; occipital region considerably depressed. Lower jaw included; maxillary not reaching to the front of the orbit; gill-rakers rather slender and weak. Dorsal fin with spines all shorter than the rays; the pectoral fins long, reaching nearly to the tips of ventrals. Head, 3½; depth, 2; D. IX or X, 20; A. III, 25. Lat. l., 58. Colors "extremely variable, pattern of color not definite. Brownish, tinged with green, blue, red, or yellowish. Sides with about 10 faint vertical dusky bars; belly usually yellowish; head with blue spots; fins dusky, tinged with blue or red"; anal frequently with yellow blotches.

10. PHANERODON* Girard.

Phanerodon Girard, Proc. Acad. Nat. Sci. Phila., v. 7, pp. 153, 321, 1854 (*furcatus*).
Phanerodon (Gd.), Gill, Proc. Acad. Nat. Sci. Phila., v. 14, p. 274, 1862.
Embiotoca sp. Girard, A. Agassiz.
Ditrema sp. Günther, 1862; J. & G., 1883.
Tæniotoca† A. Agassiz, Proc. Boston Soc. Nat. His., v. 8, 133, 1861 (*lateralis*).

Type: *Phanerodon furcatus* Girard.

ANALYSIS OF THE SPECIES OF PHANERODON.

a. Vertebræ 35–37 (21–22 abdominal); caudal peduncle deep, short..................(TÆNIOTOCA.)

- *b.* Body oblong, the dorsal and ventral profile nearly equally curved, tapering abruptly to the deep caudal peduncle; snout blunt and rounded; occipital region little depressed; mouth slightly oblique, lower lip with a frenum; gill-rakers slender and rather weak. The last spine of the dorsal fin highest, but shorter than the soft rays; soft dorsal and anal high. D. X or XI, 23; A. III, 31. Lat. l., 63. Color, "reddish olive above, becoming bright orange-red below, everywhere thickly dusted with black points; a continuous bright-blue streak along the edges of each row of scales; streaks of thoracic region formed by isolated blue spots on the middle of the scales; head with several series of blue spots and streaks; fins all olivaceous dusky; ventrals with some light orange" ....LATERALIS, 13.

aa. Vertebræ, 37–38; (23–24 abdominal) ....(PHANERODON.)

- *c.* Body oblong elliptical, dorsal and ventral outlines nearly equally curved, tapering into a slender caudal peduncle; snout projecting somewhat, a little longer than the eye; occipital region not much depressed; lower jaw included; last spine of the dorsal fin highest, nearly as high or higher than the rays; pectorals reaching a little farther than the tips of the ventrals; caudal strongly forked. Head, 3⅘; depth, 2¼; D. XI, 22; A. III, 30. Lat. l., 69. Color, "light-olivaceous, silvery below, sometimes yellowish; scales with bright reflections, but no red markings; usually a round dusky spot on the anal; ventrals plain; caudal fin edged behind with dusky; fins usually yellowish tinged" ....FURCATUM, 14.
- *cc.* Body elongate oblong, tapering gradually into a long slender caudal peduncle. Head rather small; snout projecting somewhat, as long as eye; occipital region moderately compressed; dorsal fin with highest spine about as high as the highest rays; pectorals long, reaching tips of ventrals. Head, 3¼; depth, 2⅓; D. X, 22. A. III, 28. Lat. l., 70. Color, "light olivaceous above, pearly below; scales above the axis of the body each with an orange spot at base, its outer margin tinged with blue, these forming faint reddish streaks along the rows of scales; anal with a dusky spot; ventrals broadly tipped with blackish; caudal not dark-edged." ATRIPES, 15.

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* *Phanerodon*: Φανερός, evident, and ὀδούς, tooth; referring to the size of the teeth, which were supposed to be larger than in the allied genera. Type, *Ph. furcatus* Grd.

† *Tæniotoca*: Ταινία, band, and τόκος, the terminal component of *Embiotoca*, intended to suggest the characteristic longitudinal lateral bands of the species of the genus, which is closely related to *Embiotoca*. Type, *T. lateralis*.

13. PHANERODON LATERALIS Agassiz.

Embiotoca lateralis Agassiz, Am. Journ. Sci. and Art (2), v. 17, 366, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 32, 1855; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 151, 1854; A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 126.

Tæniotoca lateralis A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 133, 1862; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868.

Damalichthys lateralis Gill, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 275, 1862 (California).

Ditrema laterale Günther, Cat. Fishes, v. 4, 245, 1862 (San Francisco, Puget Sound); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Puget Sound to Santa Barbara, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Puget Sound, Monterey, San Francisco, Santa Barbara, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Santa Barbara, Cal., to Puget Sound); Bean, Proc. U. S. N. M. 1881, 265 (Vancouver Island); Jordan & Gilbert, Syn. Fish. N. Am., 594, 1883 (Pacific coast of the United States); Bean, Proc. U. S. N. M. 1883, 361 (Departure Bay, British Columbia); Rosa Smith, West Am. Scientist, June, 1885.

Phanerodon laterale Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to Puget Sound).

Holconotus agassizi Gibbons, Proc. Acad. Nat. Sci. Phila., v. 7, 122, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 332, 1855.

Embiotoca lineata Girard, Proc. Acad. Nat. Sci. Phila., v. 7, pp. 134, 141, 151, 1854; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 320; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 346, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 6, Abbot's Report, Zoölogy, 25, 1857; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 174, pl. XXXI and XXVI, f. 5 and 6, 1859 (San Francisco, Tomales Bay, Presidio); Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Whipple's Report, Zoölogy, p. 51, 1859 (San Francisco).

Embiotoca ornata Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 321, April, 1855; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 347, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 176, pl. XXVI, f. 11.

Embiotoca perspicabilis Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 321, 1855; Archiv für Naturgeschichte, v. 1, 347, 1855; Girard, Expl. and Surv. for R. R. Route to Pac., v. 10, Fishes, 178, pl. XXXII and XXVI, f. 1, 2, 1859 (Puget Sound); Suckley, Expl. and Surv. for R. R. Route to Pac., v. 12, Stevens's Report, book 2, Zoölogy, 357.

Habitat: Vancouver Island to San Diego; rare southward.

14. PHANERODON FURCATUS Girard.

Phanerodon furcatus Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 153, 1854; Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 322, 1855; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 348; Girard, Expl. and Surv. for R. R. Route to Pacific, v. 10, Fishes, 184, pl. XXXIV, f. 1-5, 1859 (Presidio, Tomales Bay); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 128, 1862; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; E. & E., Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to San Francisco).

Ditrema furcatum Günther, Cat. Fish. Brit. Mus., IV, 247, 1862 (San Francisco); Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, California); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, Santa Barbara, San Diego); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (San Diego to San Francisco); Jordan & Gilbert, Syn. F. N. A., 596, 1883 (coast of California); Jordan, Cat. Fish. N. Am., 96, 1885; Rosa Smith, West Am. Scientist, June, 1885 (San Diego).

Embiotoca furcata Rosa Smith, A List of the Fishes of San Diego, California, 1880, November.

Habitat: San Diego to San Francisco.

15. PHANERODON ATRIPES Jordan & Gilbert.

Ditrema atripes Jordan & Gilbert, Proc. U. S. N. M. 1880, 320 (California); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Monterey Bay, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Monterey Bay, California); Jordan & Gilbert, Syn. Fish N. Am., 595, 1883 (Monterey Bay); Eigenmann & Eigenmann, West Am. Scientist, Nov., 1889, 147 (Cortes Banks).

Phanerodon atripes Eigenmann & Eigenmann, N. Y. Acad. Sci., VI, June, 1892 (Cortes Banks, Monterey).

?*Ditrema orthonotus* E. & E., West Am. Scientist, Oct., 1889, 127 (Cortes Banks)

Habitat: Monterey to Cortes Banks.

This species has so far been taken at only two localities. *D. orthonotus* will probably prove identical with *atripes*. At the time *orthonotus* was described *atripes* had not been found within 400 miles of the locality of *orthonotus*.

11. BRACHYISTIUS * Gill.

Brachyistius Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275 (*frenatus*).

Type: *Brachyistius frenatus* Gill.

ANALYSIS OF THE SPECIES OF BRACHYISTIUS.

a. Maxillary not reaching to the front of the orbit; mouth very small, oblique; head slender, pointed. Dorsal fin, VIII, 15, the sixth or seventh spine highest; body elongate, regularly elliptical. Color "dark olive-brown above, each scale with a dark spot at base, followed by a light mark; below bright coppery-red; each scale with a blue spot and dark punctulations; head colored like the body; fins all light reddish." (Jordan & Gilbert.) Head, 3⅘; depth, 3; lat. l., 40..... FRENATUS, 16.

aa. Maxillary reaching slightly beyond the vertical from the front of the orbit; mouth comparatively large, little oblique; teeth large, conical-truncate, none on the sides of the lower jaw; eye very large, its diameter about one-third the length of the head. Dorsal fin, X, 18, the spines high, the fourth or sixth highest, the fifth to tenth about equal and higher than the soft rays; anal III, 20, the spine more or less curved; pectorals not reaching tips of ventrals. Body oblong-ovate, deepest at the shoulders, dorsal and ventral outlines nearly equally curved, occipital region considerably depressed. Color "rose-red with silvery luster, darker above; top of head orange; a very distinct chocolate-colored spot above the lateral line at the origin of the soft dorsal fin; another smaller one just below the end of the soft dorsal. Fins immaculate, tinged with reddish." (Jordan & Gilbert.) Head, 3⅓; depth, 2⅓; scales, 6-50-16 ....ROSACEUS, 17.

16. BRACHYISTIUS FRENATUS Gill.

Brachyistius frenatus Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 300 (Los Angeles to Vancouver Island); Jordan & Gilbert, Proc. U. S. N. M. 1880, 465 (Puget Sound to San Pedro, California); Jordan & Jouy, Proc. U. S N. M. 1881, 10 (Monterey, Santa Barbara, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 51 (Catalina Island to Puget Sound); Rosa Smith, West American Scientist, June, 1885 (San Diego); Jordan, Cat. Fish. N. Am., 93, 1885; Eigenmann & Eigenmann, Ann. New York Acad. Sci., VI, June, 1892, 353 (San Diego to Puget Sound).

Micrometrus frenatus Bean, Proc. U. S. N. M. 1881, 265 (Puget Sound, Vancouver Island); Jordan & Gilbert, Syn. Fish. N. Am., 589, 1883 (entire Pacific coast of United States).

Ditrema brevipinne Günther, Cat. Fish. Brit. Mus., IV, 248, 1862 (Esquimault Harbor); Lord, Naturalist in Vancouver Island, v. 2, 354, 1866; Bean, Proc. U. S. N.M. 1881, 265 (Vancouver Island).

Habitat: San Diego to Puget Sound.

Very rare about San Diego, but quite abundant in some localities to the north.

Brachyistius: βραχύς, short, and ἱστίον, sail, referring to the short dorsal fin, and formed in analogy with *Histiophorus*, *Temnistia*, etc.

17. BRACHYISTIUS ROSACEUS Jordan & Gilbert.

Cymatogaster rosaceus Jordan & Gilbert, Proc. U. S. N. M. 1880, 303 (San Francisco).
Brachyistius rosaceus Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (San Francisco); Jordan & Gilbert, Proc. U. S. N. M. 1881, 51 (San Francisco, California); Jordan, Cat. Fish. N. A., 96, 1883; Eigenmann & Eigenmann, Ann. New York Acad. Sci., VI, June, 1892 (San Francisco).
Micrometrus rosaceus Jordan & Gilbert, Syn. Fish. N. A., 589, 1883 (San Francisco).

Habitat: Off San Francisco in deep water.

12. CYMATOGASTER * Gibbons.

Cymatogaster Gibbons, Proc. California Acad. Nat. Sci., in Daily Placer Times and Transcript, San Francisco (*aggregatus* and *minimus*) May 18, 1854, *fide* Agassiz (not *Cymatogaster* Gibbons, May 30, 1854, *Holconotus*); Gibbons, Proc. Acad. Nat. Sci. Phila., v. 7, 106 (*sine desc.*), June, 1854 (not *Cymatogaster* Gibbons, Aug., 1854); Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275.
Micrometrus † Gibbons, Proc. California Acad. Nat. Sci., in Daily Placer Times and Transcript, San Francisco (*sine desc.*), May 30, 1854, *fide* A. Agassiz (first species *aggregatus*); Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, 125; Jordan & Gilbert, Syn. Fish. N. A., 588, 1883 (sp.).
Holconotus Girard, Proc. Acad. Nat. Sci. Phila. 1885, 322 (not *Holoconotus* Agassiz, 1854).
Metrogaster Agassiz, MSS. (*fide* A. Agassiz); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8 (128), 133, 1861.
Ditrema sp. Günther, 1862.
Sema ‡ Jordan, Bull. U. S. Geol. and Geog. Survey, IV, No. 2, 1878 (*signifer*).

Type: *Cymatogaster aggregatus* Gibbons.

The name *Cymatogaster* was first published by Gibbons, May 18, 1854, and applied to two new species, *Cymatogaster aggregatus* and *Cymatogaster minimus*. Since these two species belong to two quite distinct genera the name can be used for but one of them. A few days later (May 30), Gibbons applied the name *Micrometrus* to the same two species. On June 21 he restricted the name *Cymatogaster* to *pulchellus*, a nominal species not known at the time (May 18) the name was first proposed. The later use of the name is entirely untenable, since *Cymatogaster* was a name preoccupied by its use of May 18, just as much as if it had been used for a genus of reptiles fifty years before. This seems self-evident and it ought not to be necessary to defend this view. *Cymatogaster*, if used at all, must be used for *aggregatus* or *minimus*. The same is true of *Micrometrus*.

The first species to be eliminated from these two under a separate generic name was *minimus*. Girard described a species, *trowbridgii*=*minimus*, under the new generic name *Abeona*, thus restricting both *Cymatogaster* and *Micrometrus* to the only other species of the original *Cymatogaster*, viz, *aggregatus*.

There seems, then, no other way out of the difficulty than to retain the name *Cymatogaster aggregatus*, to which it was restricted by Dr. Gill in 1862.

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* *Cymatogaster:* Κῦμα(ατος), fœtus, and *γαστηρ*, belly, alluding to the viviparity common to the whole family, first sp., *C. aggregatus*.

† *Micrometrus:* Μικρος, small, and *μετρον* measure (quasi size), referring to the comparatively small size of the representatives of the genus, first sp., *M. aggregatus*.

‡ *Sema:* *σῆμα*, a banner, in allusion to the high fins.

3. HYPERPROSOPON ANALIS A. Agassiz.

Hyperprosopon analis A. Agassiz, Proc. Boston Soc. Nat. Hist., VIII, 133, 1861 (name only); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (Port Harford and Monterey).

Hypocritichthys analis Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 275 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868.

Ditrema anale Günther, Cat. Fish. Brit. Mus., IV, 250, 1862 (California).

Holconotus analis Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Monterey Bay, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 51 (San Francisco to San Luis Obispo, California); Jordan, Cat. Fish. N. Am., 996, 1885.

Amphistichus analis, Jordan & Gilbert, Syn. Fish. N. Am., 591, 1883.

Habitat: Port Harford to San Francisco. Rare.

4. HYPERPROSOPON ARGENTEUS Gibbons.

Hyperprosopon argenteum Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 105 (San Francisco); l. c. 125; *id.*, Archiv. für. Naturg., 21. Jahrg., B. 1, 338, 1855; A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 132, 1861; Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 276 (California); Cooper, Nat. Wealth Cal. by Crouise, 489, 1868; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego, San Pedro to San Francisco).

Holconotus argenteus Rosa Smith, A List of the Fishes of San Diego, California, 1880, Nov.; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, California); Jordan, Proc. U. S. N. M. 1881, 10 (Monterey, San Francisco, Santa Barbara, and San Diego, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to San Diego, California); Rosa Smith, West Am Scientist, 1885, June; Jordan, Cat. Fish. N. A., 96, 1885 (name).

Hyperprosopon argenteum punctatum Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 106 (fide Gill).

Hyperprosopon arcuatus Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 125; Archiv. f. Naturg. 1855, B. 1, 339; Gill, Proc. Acad. Nat. Sci. Phila. 1862, v. 14, 275 (California); Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, California).

Ditrema arcuatum Günther, Cat. Fish. Brit. Mus., IV, 249, 1862 (San Francisco).

Amphistichus arcuatus Jordan & Gilbert, Syn. Fish. N. A., 591, 1885 (Cape Mendocino and southward).

Holconotus megalops Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 152.

Ennichthys megalops Girard, l. c., 323; Archiv. f. Naturg. 1855, B. 1, 351; Girard, Pacific R. R. Survey, v. 6, 26; *id.*, l. c., v. 10, 197, pl. XXXVII and XXVI, fig. 10 (Presidio, Humboldt Bay, Astoria).

Ditrema megalops Günther, Cat. Fish. Brit. Mus., IV, 249, 1862.

Habitat: Astoria to Ensenada.

5. HYPERPROSOPON AGASSIZI Gill.

Hyperprosopon arcuatum A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 133, 1861 (not of Gibbons).

Hyperprosopon agassizi Gill, Proc. Acad. Nat. Sci. Phila., v. 14, 276, 1862 (California); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (Santa Barbara to San Francisco).

Ditrema agassizi Günther, Cat. Fish. Brit. Mus., IV, 250, 1862 (San Francisco).

Holconotus agassizi Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to Santa Barbara, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey and San Francisco, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to Santa Barbara, Cal.); Jordan, Cat. Fish. N. Am., 96, 1885 (name only).

Amphistichus agassizi Jordan & Gilbert, Syn. Fish. N. A., 592, 1883 (California).

Hyperprosopon punctatum Cooper, Nat. Wealth Cal. by Cronise, 486, 1868.

Habitat: Santa Barbara to San Francisco.

13. ABEONA[*] Girard.

Cymatogaster Gibbons, Daily Placer Times and Transcript, May 18, 1854 (sp.).

Micrometrus Gibbons, l. c., May 30, 1854 (sp.); A. Agassiz, Proc. Bost. Soc. Nat. Hist. 1861, 128 and 133 (restricted to *minima*).

Abeona Girard, Proc. Acad. Nat. Sci. Phila. 1855, 322 (*trowbridgii*).

Type: *Abeona trowbridgii*=*A. minima* Gibbons.

ANALYSIS OF THE SPECIES OF ABEONA.

a. Color greenish above with bluish reflections, thickly dusted with black dots; an irregular longitudinal black band along axis of body, and two vertical dark bars downward from base of dorsal fin on which they appear as blotches; sides often with much light yellow; axil of pectorals black." (Jordan & Gilbert.) Body ovate, dorsal and ventral outlines nearly evenly curved; mouth small, jaws about equal, the maxillary reaching about half the distance to the front of orbit. Scales of cheeks in two and a half rows. Dorsal fin high, the last spine about as long as the first soft ray; pectorals not reaching as far as ventrals. D. IX, 44; A. III, 17; scales, 4–45–12; head, 3¼; depth, 2 .... MINIMA, 19.

aa. Color bluish black above, becoming lighter on the sides and silvery below. Opercles and lower half of sides punctate with black dots and shaded with light orange, the latter more intense on the centers of the scales and forming a diffuse lateral band; a broad, grayish streak backwards from pectorals to opposite origin of anal, this streak without orange points; young specimens with the bright lateral shades more distinct, and rosy instead of orange; fins marked with more or less blackish, the anal with some yellowish, a conspicuous black triangular blotch in the axil of the pectoral. Body elongate, with a very long and rather thick caudal peduncle. Head transversely very convex above and with a blunt snout. Mouth small, oblique; maxillary reaching but two-thirds the distance to front of orbit; caudal forked for half its length. Scales on cheek in three distinct series. Head, 4; depth, 2¾. D. IX, 17; A. III, 20; lat. l., 45. (Jordan & Gilbert.) .... AURORA, 20.

19. ABEONA MINIMA Gibbons.

Cymatogaster minimus Gibbons, Proc. Cal. Acad. Nat. Sci., in Daily Placer Times and Transcript, May 18, 1854; *id.*, Proc. Ac. Nat. Sci. Phila., v. 7, 106, 1854.

Micrometrus minimus Gibbons, Proc. Cal. Acad. Nat. Sci., in Daily Placer Times and Transcript, May 30, 1854; *id.*, Proc. Ac. Nat. Sci. Phila., v. 7, 125, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 339, 1855; A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 129, 1861.

Ditrema minima Günther, Cat. Fishes Brit. Mus., IV, 249, 1862 (San Francisco).

Abeona minima Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275 (footnote); Cooper, Nat. Wealth Cal. by Cronise, 489; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, Cal.); Rosa Smith; A list of the Fishes of San Diego, Cal., November, 1880; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, Santa Barbara, and San Diego, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 51 (Tomales to San Diego, Cal.); Jordan & Gilbert, Syn. Fish. N. Am., 587, 1883 (Pacific Coast of the United States); Rosa Smith, West. Am. Scientist June, 1885; Jordan, Cat. Fish. N. Am., 96, 1885; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to San Francisco).

Holconotus trowbridgii Girard, Proc. Acad. Nat. Sci. Phila., v. 7, 152, 1854

Abeona trowbridgii Girard, Proc. Ac. Nat. Sci. Phila., v. 7, 322; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 349, 1855; Expl. and Surv. for R. R. Route to Pacific, v. 10, Fishes, 186, pl. XXXIV, f. 6–10.

Habitat: San Diego to San Francisco.

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[*] *Abeona*, an Indian name, probably.

7. AMPHISTICHUS ARGENTEUS Agassiz.

Amphistichus argenteus Agassiz, Am. Journ. Science and Arts (2), v. 17, 367, 1854 (California); Archiv für Naturg. 1855, B. 1, 34; Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 141 and 153; *id.*, l. c., 323; *id.*, Archiv. f. Naturg. 1855, B. 1, 352; *id.*, Pacific R. R. Survey, v. 10, 201, pl. XXXIX, 1859 (San Francisco, Presidio); *id.*, l. c., Whipple's Report, 51, 1859 (San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco); Agassiz, Proc. Boston Soc. Nat. Hist. 1861, 131; Gill, Proc. Acad. Nat. Sci. Phila. 1862, 275 (California); Cooper, in Cronise Nat. Wealth Cal., 489, 1868; Rosa Smith, A List of the Fishes of San Diego, Cal., Nov., 1880; Jordan & Gilbert, Proc. U. S. N. M. 1880, 28 (San Diego, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Diego, Cal.); Jordan & Jouy, Proc. U. S. N. M. 1881, 10 (Monterey, San Francisco, Santa Barbara, Cal.); Jordan & Gilbert, Proc. U. S. N. M. 1881, 50 (Tomales to San Diego, Cal.); Jordan & Gilbert, Syn. Fish. N. A., 593, 1883 (California); Jordan, Cat. Fish. N. Am., 96, 1885; Rosa Smith, West Am. Scientist, June, 1885 (San Diego); Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to San Francisco).

Ditrema argenteum Günther, Cat. Fish. Brit. Mus., IV, 251, 1862 (San Francisco); Lord, Naturalist in Vancouver Isl. and Brit. Col., I, 120, pl. opposite p. 160, 1866.

Mytilophagus fasciatus Gibbons, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 125 (San Francisco); *id.*, Archiv f. Naturg., 1855, B. 1, 340.

Amphistichus heermanni Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 135.

Ennichthys heermanni Girard, l. c., 323; *id.*, Archiv f. Naturgeschichte, 1855, B. 1., 351; *id.*, Pacific R. R. Survey, v. 10, 199, pl. XXXVIII and XXVI, fig. 9, 1859 (Cape Flattery, San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco).

Amphistichus similis Girard, Proc. Acad. Nat. Sci. Phila. 1854, v. 7, 153; *id.*, l. c., 323, 1855; *id.*, Archiv f. Naturg. 1855, B. 1, 353; *id.*, Pacific R. R. Survey, 203, pl. XXXVI, fig. 5–9, 1859 (San Francisco); *id.*, l. c., Williamson's Report, 88, 1859 (San Francisco).

Habitat: San Diego to Cape Flattery.

Body ovate, the dorsal profile much more curved than the straightish ventral outline. Mouth slightly oblique, comparatively large. Snout longer than the rather small eye. Interorbital region little depressed; maxillaries not included under the orbital, reaching to the front of the pupil; lower jaw included. Dorsal spines strong, the fifth or sixth longest, not so long as the soft rays; pectorals slightly falcate, reaching almost to the tips of the ventrals. Head, 3½; depth, 2¼; D. X, 24; A. III, 26; lat. l., 67. Color, "silvery; sides with narrow vertical bars of a brassy olive color, alternating with vertical series of spots of similar color; fins plain; vertical fins sometimes edged with dusky." A few specimens have been observed in which the sides were uniformly brassy.

6. RHACOCHILUS Agassiz.

Rhacochilus[*] Agassiz, Am. Journ. Science and Art, (2) v. 17, 367, May, 1854 (*toxotes*).

Pachylabrus[†] Gibbons, Proc. Cal. Acad. Sci. in Daily Placer Times and Transcript, San Francisco, June 21, 1854.

Type: *Rhacochilus toxotes* Agassiz.

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[*] *Rhacochilus:* Ῥάκος rag, and χεῖλος, lip; referring to the slashed lips of the adult.

[†] *Pachylabrus:* Παχύς, thick and *labrus*, lip; a hybrid word alluding to the thickened lips.

8. RHACOCHILUS TOXOTES Agassiz.

(Plate XCII, fig. 2.)

Rhacochilus toxotes Agassiz, Am. Journ. Sci. and Art (2), v. 17, 367, 1854; Archiv für Naturgeschichte, 21. Jahrg., B. 1, 33; Girard, Proc. Acad. Nat. Sci. Phila., v. 8, 136, 1856; Girard, Expl. and Surv. for R. R. Route to Pacific, v. 10, Fishes, 188, pl. XL, 1859 (Tomales Bay); A. Agassiz, Proc. Boston Soc. Nat. Hist., v. 8, 130, 1861; Cooper, Nat. Wealth Cal. by Cronise, 489, 1868; Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (San Francisco to San Pedro, California); Jordan & Jouy, Proc. U. S. N. M. 1881, 11 (Monterey, Wilmington, Santa Barbara, San Francisco, California); Jordan & Gilbert, Proc. U. S. N. M. 1881, 49 (San Pedro to San Francisco, California); Eigenmann, 1890; Jordan & Gilbert, Syn. Fish. N. A., 596, 1883 (California); Jordan, Cat. Fish. N. Am., 96, 1885; Eigenmann & Eigenmann, Ann. N. Y. Acad. Sci., VI, June, 1892 (San Diego to San Francisco).

Ditrema toxotes Günther, Cat. Fish. Brit. Mus., IV, 247, 1862 (San Francisco).

Pachylabrus variegatus Gibbons, Proc. Acad. Nat. Sci. Phila., v. 7, p. 126; Archiv für Naturgeschichte, 21 Jahrg., B. 1, p. 311, 1855.

Habitat: San Francisco to San Diego.

Body ovate, tapering abruptly into a long and robust caudal peduncle; mouth comparatively large, the lower jaw included; eye large; the soft dorsal rays considerably higher than the low spinous dorsal; caudal short, deeply forked, the upper lobe the longer; pectorals and ventrals long. Head, 3⅖; depth, 2⅖; D. X, 23; A. III, 30; lat. line, 76. Color olivaceous with brassy reflections and dusky points; fins plain.

7. **NEODITREMA** Steindachner & Döderlein.

Neoditrema Steindachner & Döderlein, Denk. Ak. Wiss. Wien, XLVII 32, 1883 (*ransonneti*).

Type: *Neoditrema ransonneti* St. & D.

This genus is described as a *Ditrema* without teeth in its jaws.

9. NEODITREMA RANSONNETI Steindachner & Döderlein.

Neoditrema ransonneti Steindachner & Döderlein (Yokohama, Tokio).

Habitat: Japan.

Strongly compressed, especially below the pectorals; profile to occipital process concave; mouth greatly protractile; head pointed, mouth oblique; lower jaw included; maxillaries concealed under preorbital, reaching to eye. Dorsal spines graduated from the first to the last, which is equal to the snout and half the eye in length; caudal widely forked, about equal to the head exclusive of snout. Back dusky, golden yellow below lateral line; base and tip of caudal dusky, remainder of fin yellow. Head, 3⅔ to 3¾; depth, 3⅓; D. VI–VIII, 21 or 22; A. III, 26–27. Lat. l., 70. Br., 5. (Steindachner.)

8. **DITREMA*** Schlegel.

Ditrema Schlegel, Fauna Japonica, 77, pl. XL, fig. 2.

Ditrema Bleeker, Verh. Batav. Genootsch, XXV, 33 (*temminckii*).

Ditrema Brevoort, Narrative U. S. Exped. to Japan (Perry's), II, 265, 1856 (first referred to the family *Embiotocidæ*).

Ditrema Günther, Cat. Fish Brit. Mus., IV, 244, 1862 (=*Embiotocidæ*).

Ditrema Jordan & Gilbert, Syn. Fish N. A., 594, 1883 (=several genera).

Type: *Ditrema temminckii* Bleeker.

**Ditrema:* Δις, double, and *τρῆμα*, hole; referring to the presence of the special generative aperture in addition to the anal one.

10. DITREMA TEMMINCKII Bleeker.

Ditrema, Schlegel, l. c. (abundant in spring in Bay of Nagasaki); Gill, Proc. Phil. Acad. Sci. 1862, 126.

Ditrema temminckii Bleeker, l. c.; Brevort, l. c. (Hakodadi, in latitude 41° 49′ N.); Günther, Cat. Fish. Brit. Mus., iv, 246, 1862 (Japan); Bleeker, "Notices Ichthyologiques No. x."; Putnam, "Bull. Mus. Comp. Zool."; Nyström, Sv. Ak. Hand., xiii, afd. 4, No. 4, p. 32 (Japan).

Ditrema læve Günther, Cat. Fish. Brit. Mus., ii, 392, 1860 (Japan.)

Habitat: Japan.

Brevoort says, l. c.:

> The genus *Ditrema* was established by Schlegel upon examination of two stuffed specimens and a native figure of a fish which offered the peculiarity of two anal orifices. * * * He gave the fish no specific name. * * * The figure by the artists of the United States Japan Expedition is identical with the one in the Fauna Japonica, though rather darker in coloring. It does not show the specific characters distinctly. * * * Upon showing the published figure of the *Ditrema*, and the figure of it by the American artist, to Diengkitch, he immediately described its viviparous faculty. * * * In the list of fishes * * * is one called in Chinese *Ju* or *Lian*, in Japanese *Tanako*, "a fish which swims in pairs"; and in a footnote Mons. A. Remusat (Notices et Extraits des Manuscrits, tome xi, part 1, 1827, p. 216) says: "It is asserted that this fish is viviparous * * *." This very interesting note, the authority for which is not given, induced me to compare the *Ditrema* with a specimen of the California viviparous fish procured by Dr. John LeConte in that country in 1851, and with the descriptions of the *Embiotocidæ* and *Holconoti*, by Agassiz * * * "when no doubt remained on my mind that species of the same family of fish were thus proved to occur on the Asiatic coast of the Pacific also.

11. DITREMA SMITTII Nyström.

Ditrema smittii Nyström, Sv. Ak. Handl., xiii, 4, afd. No. 4, p. 32, 1887 (Japan).

We add here the original description, a copy of which has been furnished by Dr. Theo. Gill:

No. 86. Ditrema smitti* n. sp.

Diagn.—Kroppens höjd ungefär $\frac{1}{3}$ af totallängden; bakre delen af analfenan betydligt högre än den främre, och 17:de—20:del strålarne tradformigt förlängda; brostfenornas spetsar nä till analfenans början.

R. f. 11+21. A. f. 3+27. Br. f. 17. L. lat. 78. l. tr. $\frac{11}{13}$.

Kroppsformen är något mera långstrackt än hos föregående, med hvilken denna art för öfrigt synes visa närmaste slägtskapen, och största kroppshöjden utgör ungefär $\frac{1}{3}$, och hufvudets längd $\frac{1}{4}$ af total-längden. Ögats diameter innehålles i det närmaste 4 ggr., och nosens längd, som är lika med pannans bredd mellan ögonen, $3\frac{1}{3}$ ggr. i hufvudets längd.

Nosen öfre profilkontur är svagt konvex, och mellan ögonen är en framskj utande knöl, bakom hvilken pannan åter är något intryckt. Bakre delen af hufvudet är mera konvex och starkare uppstigande, dock ej så mycket som hos föregånde art. Ryggen är temligen jåmnt böjd till slutet af ryggfenan, och afståndet från basen af den sista ledade strålen till spetsen af stjärtfenans öfre flik är något större än hos D. laeve, och lika med afståndet från nosspetsen till bukfenornas rot.

Främre afdelningen af ryggfenan är läg och taggsträlarne tilltaga successivt i längd bakåt; den sista är dock något lägre än den första ledade strålen, och dess längd uppnår ungefäar $\frac{1}{3}$ af hufvudets. Den mjukstråliga delen af ryggfenan är temligen jämnt afrundad, och de mellersta strålarne, som äro de längsta, innehållas omkring 2ggr. i hufvudets längd.

Analfenan har den bakre afdelingen, från med den 16:de strålen, betydligt högre ån den främre, och öfvergången mellan de båda afdelnidgarne sker hastigt, så att den 16: de strålen är i det närmaste dubbelts å lång som den före gående. 17:de—20:de fenstrålarne äro trädformigt förlängda, och af dessa äro de båda mellersta längst och ungefär lika långa som bröstfenorna.

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* Arten är uppkallad after en af gifrarne, Herr J. C. Smitt i Japan.

The following species are found in American waters:

List of the species of Embiotocidæ found in American waters.

[Shore fishes unless otherwise specified.]

Species.	Distribution.
Hypsurus caryi Agassiz	San Diego to San Francisco
Damalichthys argyrosomus Girard	San Diego to Puget Sound.
Hyperprosopon analis Agassiz	Port Harford to San Francisco.
Hyperprosopon argenteus Gibbons	Encenada to Astoria.
Hyperprosopon agassizi Gill	Santa Barbara to San Francisco.
Holconotus rhodoterus Agassiz	San Diego to San Francisco.
Amphistichus argenteus Agassiz	San Diego to Cape Flattery.
Rhacochilus toxotes Agassiz	San Diego to San Francisco.
Embiotoca jacksoni Agassiz	San Diego to Puget Sound.
Phanerodon lateralis Agassiz	San Diego to Puget Sound.
Phanerodon furcatus Girard	San Diego to San Francisco.
Phanerodon atripes Jordan & Gilbert	Cortes Bank to Monterey.
Brachyistius frenatus Gill	San Diego to Puget Sound.
Brachyistius rosaceus Jordan & Gilbert	Off San Francisco, deep water.
Cymatogaster aggregatus Gibbons	San Diego to Puget Sound.
Abeona minima Gibbons	San Diego to San Francisco.
Abeona aurora Jordan & Gilbert	Monterey Bay.
Hysterocarpus traskii Gibbons	Fresh waters of Central California.

Of all these, *Cymatogaster aggregatus* is one of the most abundant species between San Diego and San Francisco.

In the deeper water the viviparous species of *Scorpænidæ* replace the *Embiotocidæ*.

The following species of viviparous *Scorpænidæ* are found on the west coast of America:

List of species of viviparous Scorpænidæ found on the West Coast of America.

Name of species.	Vertical distribution.	Horizontal distribution.
Sebastolobus alascanus Bean	960 feet	Off Trinity Islands.
Sebastolobus macrochir (Günther)	2,100 feet	Southern California to Japan.
Sebastichthys nigrocinctus (Ayres)	Deep water	Monterey to Vancouver Island.
Sebastichthys serriceps J. & G	10 to 90 feet	Cerros Island to San Francisco.
Sebastichthys rubrovinctus J. & G	300 to 600 feet	San Diego to Monterey.
Sebastichthys diplaproa Gilbert	740 feet	Southern California.
Acutomentum melanostomus (E. & E.)	600 to 1600 feet	San Diego.
Acutomentum macdonaldi E. & B	600 feet	San Diego.
Acutomentum ovalis (Ayres)	300 feet	San Diego to San Francisco.
Acutomentum alutus (Gilbert)	900 feet	Southern California.
Primospina mystinus (Jordan & Gilbert)	100 feet	San Diego to Puget Sound.
Primospina entomelas (Jordan & Gilbert)	(?)	Port Harford to Monterey.
Sebastosomus flavidus (Ayres)	90 feet	San Diego to San Francisco.
Sebastosomus serranoides (E. & E.)	100 to 300 feet	San Diego to San Francisco.
Sebastosomus melanops (Girard)	90 feet	Monterey to Sitka.
Sebastosomus ciliatus Tiles	(?)	Alaska.
Sebastodes paucispinis (Ayres)	90 to 600 feet	San Diego to San Francisco.
Sebastodes goodei E. & E	600 to 900 feet	San Diego to San Francisco.
(?) matzubaræ Hilgendorf	(?)	Alaska.
Sebastomus capensis Linnæus	(?)	Coast of Chili and Cape Seas.
Sebastomus rufus (E. & E.)	600 feet	San Diego.
Sebastomus miniatus (J. & G.)	100 to 600 feet	San Diego to San Francisco.
Sebastomus pinniger (Gill)	600 feet	San Diego to Puget Sound.
Sebastomus levis (E. & E.)	250 to 600 feet	San Diego to Monterey.
Sebastomus æreus (E. & E.)	250 to 600 feet	San Diego.
Sebastomus constellatus (J. & G.)	90 to 300 feet and deeper?	San Diego to San Francisco.
Sebastomus umbrosus (J. & G.)	(?)	Santa Barbara.
Sebastomus rosaceus (Girard)	100 feet	San Diego to San Francisco.
Sebastomus rhodochloris (J. & G.)	Deep water	Monterey to San Francisco.
Sebastomus gilli (E.)	600 feet	San Diego.
Sebastomus rupestris (Gilbert)	900 feet	Southern California.
Sebastomus eos (E. & E.)	600 feet	San Diego.
Sebastomus chlorostictus (J. & G.)	300 feet	San Diego to San Francisco.

List of species of viviparous Scorpænidæ found on the West Coast of America—Continued.

Name of species.	Vertical distribution.	Horizontal distribution.
Sebastomus ruber (Ayres)	300 feet	San Diego to Puget Sound.
Pteropodus sinensis (Gilbert)	870 feet	West coast Lower California.
Pteropodus saxicola (Gilbert)	960 feet	Southern California.
Pteropodus atrovirens (J. & G.)	(?)	San Diego to San Francisco.
Pteropodus elongatus (Ayres)	300 feet	San Diego to San Francisco.
Pteropodus proriger (J. & G.)	300 to 600 feet	San Diego to San Francisco.
Pteropodus brevispina (Bean)	(?)	Alaska.
Pteropodus zacentrus (Gilbert)	900 feet	Southern California.
Pteropodus maliger (J. & G.)	(?)	Monterey to Sitka.
Pteropodus rosæ E	30 feet above high water.	Port Harford. Fossil.
Pteropodus dallii (E. & B.)	(?)	San Francisco.
Pteropodus caurinus (J. & G.)	(?)	Puget Sound to Sitka.
Pteropodus vexillaris (J. & G.)	60 to 600 feet	San Diego northward.
Pteropodus rastrelliger (J. & G.)	(?)	San Diego to San Francisco.
Pteropodus nebulosus (Ayres)	Deep water	Port Harford to Vancouver Island.
Pteropodus carnatus (J. & G.)	Shallow water	San Diego to San Francisco.
Pteropodus chrysomelas (J. & G.)	100 feet	San Diego to San Francisco.
Auctospina aurora (Gilbert)	1,600 feet	Southern California.
Auctospina auriculatus (Girard)	Surface	Cerros Island to Vancouver Island.

The depths are only approximate. I have given the shallowest and deepest waters recorded (mostly in my notes) for each species. I have found them very abundant, both in individuals and in species, to a depth of about 600 feet, the depth at which much of the winter fishing is done in the neighborhood of San Diego. Dr. Gilbert, when with the *Albatross*, found a number of species at a depth of 1,600 feet.

A contemplation of these long lists of viviparous fishes naturally leads one to suppose that peculiar conditions must exist, or must have existed, to develop such an amazing number of viviparous forms. The action of environment, or the production of similar results by similar causes acting upon so widely separated families as the *Embiotocidæ* and *Scorpænidæ*, seems evident. The conditions must here have been, and probably are, more favorable to the survival of those species producing living young than elsewhere. That the conditions must have been favorable to viviparous species for a long period is evidenced by the large number of species now existing and by the advanced stage of viviparity of the *Embiotocidæ*. *Cymatogaster* far surpasses all other known species of fishes in the degree of its viviparity.

If the degree of viviparity is a criterion, the *Embiotocidæ* have been much longer viviparous than the *Scorpænidæ*, and I have discovered a fossil *Pteropodus** (*rosæ*) in the cretaceous at Port Harford. The *Embiotocidæ* would, therefore, date back still earlier. What these conditions are, or have been, is of course a difficult question to determine.

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*There is a possibility that the deposit from which the fragments of this species were taken is in part a prehistoric refuse heap, in which case this observation loses much weight. At Port Harford a rather steep hill rises several hundred feet from the beach. At about 20 feet from high-water mark there is an old railroad cut. In the bank thus exposed, which was water-worn at the time I visited it, there were found many fragments of fish bones, chiefly vertebræ, and crustacean shells and mollusks. The mollusks, which were unquestionably fossil, were similar to those found all over the hill, even to its top; crustacean shells and fish bones I found only at this cut, about 2 feet from the surface. Among the fragments of fish bones I found a part of a preopercle of a *Pteropodus* allied to *nebulosus*. The most of the fragments have not been identified.

TYPES OF VIVIPARITY IN TELEOSTS.

At least two types of viviparity may be distinguished in fishes: first, those in which the yolk furnishes all the intraovarian food (*Pœcilia*,[*] *Gambusia*, *Scorpænidæ*[†]); and second, those in which the greater part of the food is furnished by the ovary (*Blennius*,[‡] *Anableps*,[§] and *Embiotocidæ*).

In the first type the number of young is usually not less than in related oviparous forms, while the number of young in the second is always greatly reduced.

In the largest of the *Scorpænidæ*, *Sebastomus levis*, which reaches a weight of about 30 pounds, the ripe eggs, about 1 mm. in diameter, would fill several quarts;[¶] since each of these develops into a larva before it is freed from the ovary, the maximum number of living young produced by this class of viviparity reaches many thousands. Stuhlmann in 1887 recorded 405 young for *Zoarces*; this he considered a remarkable number.

The size and comparative development of the young of this class of fishes at the time of birth is of course much less than in the second class of viviparous fishes.

The number of young observed in different species of viviparous fishes is as follows: *Sebastomus*, many thousands; *Sebastes marinus* (*fide* Ryder), 1,000; *Gambusia patruelis* (*fide* Ryder), 20 to 25; *Anableps gronovii* (*fide* Wyman), mother 7 inches long, with 4 to 5; 10 inches long, 18; 10 inches long, 7, each about 2¼ inches long.

Embiotocidæ.—The number of young in any species varies greatly with the age of the parent: *Hysterocarpus traski*, 16; *Hyperprosopon argenteus*, 7 to 12 (Dec. 17); *Hypsurus caryi*, 8; *Ditrema jacksoni*, 8[‖] to 60; *Phanerodon lateralis*, 21 to 80; *Phanerodon furcatus*, 10 to 23; *Amphistichus argenteus*, 47 to 80.

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[*] In *Pœcilia* (Duvernoy, 1844) and in *Gambusia* (Ryder, 1885) the egg is fertilized and the embryos remain in the original ovarian follicle till near the close of gestation.

[†] In the *Scorpænidæ* (Ryder, 1886; Eigenmann & Eigenmann, Proc. U. S. Nat. Mus. 1892) the follicle is ruptured before impregnation takes place, but the egg remains mechanically inclosed within it, and the blood supply of the follicles is continued till near the end of gestation. The term of gestation in *Sebastichthys* (*rubrovinctus*) lasts perhaps little over two months.

[‡] In *Blennius* (Rathke, 1833; Stuhlman, 1887) the egg is impregnated while still in the follicle, in which it undergoes the early stages of its development. At the end of three weeks it is freed; the embryos remain three months longer in the ovary. The food supply seems to be furnished through the old follicles, and this method is but an extension of that found in *Sebastes* and its relatives.

[§] In *Anableps* (Wyman, 1850), whose early stages have not been observed, the larvæ are surrounded by a vascular membrane, which is connected with the ovarian wall, even in embryos an inch long. The stages before the absorption of the yolk have not been observed. The yolk bag increases in size and is provided externally with a series of papillæ.

[¶] A very moderate estimate would be 2 quarts.

[‖] The small number of young in Agassiz's specimens was probably due to the *lateness of the season*, a time when only small individuals are still with young.

HISTORICAL NOTICE OF EMBIOTOCIDÆ.

The fact that the species of *Embiotocidæ* are viviparous was nearly simultaneously discovered by J. K. Lord, at Vancouver Island; A. C. Jackson, at San Francisco, June 7, 1852; W. P. Gibbons, at San Francisco; and Dr. Thomas H. Webb, May 3, 1852, at San Diego.*

Prof. Agassiz published the first account of these fishes in 1853 (collected by Jackson).

The interest excited by the announcement of the discovery is shown by the following account from Prof. Gill's "Prefatory" of his Bibliography of the Fishes of the Pacific Coast of the United States to the end of the year 1879. He states:

> The fishes of California remained absolutely unknown till 1839, when a glimpse, but an entirely inadequate one, was furnished by Lay and Bennett in their notes and account of species collected during the voyage of the English vessel *Blossom*; a long silence then supervened, and, with the exceptions thus signalized, and the addition by Storer of a single species of *Syngnathus* in 1846, west-coast ichthyography commenced in 1854 with the announcement by Prof. Agassiz of the discovery of the remarkable family of Embiotocoids. This was speedily followed by numerous communications by Dr. Gibbons, Dr. Girard, and Dr. Ayres, on new species of fishes, mostly from the Californian waters, but partly from Oregonian ones. As early as 1858 nearly two hundred species had been made known.

The exact date of Lord's and Gibbons's † observations I do not know, but Webb has a whole month's priority over Jackson. Jackson, however, communicated his discovery to Louis Agassiz, so that his observations were made public in the fall of 1853, and Dr. Webb's not until May, 1854, and more fully in 1858, while Lord's account did not appear till 1866. Since the notes are brief I will give in their own words the observations of these gentlemen. Gibbon's account I have not seen. Mr. Jackson, in a letter to Agassiz, states:

> On the 7th of June I arose early in the morning for the purpose of taking a mess of fish for breakfast; pulled to the usual place, baited with crabs, and commenced fishing, the wind blowing too strong for profitable angling. Nevertheless on the first and second casts I fastened the two fishes, male and female, that I write about, and such were their liveliness and strength that they endangered my slight trout rod. I however succeeded in bagging both, though in half an hour's subsequent work I got not even a nibble from either this or any other species of fish. I determined to change the bait to put upon my hook a portion of the fish already caught and cut for that purpose into the largest of the two fish caught. I intended to take a piece from the thin part of the belly, when what was my surprise to see coming from the opening thus made a small live fish. * * * I was vastly astonished to find next to the back of the fish and slightly attached to it a long very light violet bag so clear and so transparent that I could already distinguish through it the shape, color, and formation of a multitude of small fish (all facsimiles of each other) with which it was well filled. * * * There can not remain in the mind of any one who sees the fish in the same state that I did, a single doubt that these young were the offspring of the fish from whose body I took them, and that this species of fish gives birth to her young alive and perfectly formed, and adapted to seeking its own livelihood in the water. The number of young in the bag was nineteen and every one as brisk and lively and as much at home in a bucket of salt water as if they had been for months accustomed to the water.

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* Brevoort records a specimen of viviparous fish discovered by Dr. John L. LeConte in 1851. See *ante* under "*Ditrema temminckii*," and Prof. Geo. Davidson, of the U. S. Coast Survey, tells me that he had noted their viviparity long before any published notices of the fact appeared.

† Agassiz (1854, 368), states: "I have just been informed (February 28 [1854]) that the California Academy of Natural Sciences claims for Dr. W. P. Gibbons the discovery of the viviparous fishes upon which I had established the family *Holconoti*. * * * Dr. Thomas H. Webb, one of the scientific corps of the Mexican Boundary Line Commission, has sent me * * * the following abstract from his diary dated San Diego, May 3, 1852: 'Caught * * * a number of small fish, about 2 or 3 inches long, each of which contained ten or twelve living young.'"

This species was *Ditrema jacksoni*. Agassiz adds a note as follows:

> It will be a matter of deep interest to trace the early stages of growth of these fishes, to examine the structure of the ovary and the eggs before fecundation takes place, etc.

This was, however, not done in the forty years after the above was written.

Prof. Agassiz described the structure of the ovary as follows:

> It consists of a large bag. * * * Upon the surface of it large vascular ramifications are seen, and it is subdivided internally into a number of distinct pouches, opening by wide slits into the lower part of the sack. This sack seems to be nothing but the widened lower end of the ovary, and the pouches within it to be formed by the folds of the ovary itself. In each of these pouches a young is wrapped up as in a sheet and all are packed in the most economical manner as far as saving space is concerned, some having their head turned forwards and others backwards. This is therefore a normal ovarian gestation.

He further gives the relative sizes of adult and young.

Dr. Webb's account as given by Girard is as follows:

> On May 3 (1852), during boisterous and cold weather, Capt. Ottringer caused his seine to be drawn across the harbor (San Diego). Caught many tiger and shovel-nose sharks, two flounders, two specimens of a fish somewhat like our sculpin, also a number of small fish about 3 or 4 inches long, each of which contained ten or twelve living young.

Girard (1858, p. 165) adds the following to Webb's account:

> Eggs are formed within the texture of the ovarian membranes themselves. * * * The sheath (ovarian walls) and the ovaries are gradually increasing in bulk, as the eggs themselves first increase in size and the embryos afterwards. The sheath is chiefly a muscular membrane, whilst the ovaries are altogether vascular.
>
> When mature, the eggs either fall into the space between the membrane or ovarian pouches, or else remain attached to the ovaries until the embryos issue out of them. We are inclined to think that they drop into the pouches as eggs. At any rate we found very young embryos loosely contained in the ovarian pouches, when no trace of the egg membrane could be seen within the tissues of the ovaries.
>
> After leaving the eggshell they have an abdominal bag containing the remaining yolk,* which is gradually absorbed during a period when neither the mouth nor the œsophagus are formed. * * * The soft and articulated portions of the dorsal and anal fins next assume a development reaching extraordinary proportions, which they again gradually lose as soon as free from parental sheltering.

Under the head of *Embiotica jacksoni* he states:

> To the upper roof of the sheath are firmly attached some highly vascular membranes hanging downwards and dividing the whole tube into elongated pouches or compartments. Five of these vascular membranes were found to be present, and by an attentive examination it was soon discovered that they were in fact the true ovaries, two in number, as required by the law of symmetry.

Mr. Lord (1866, pp. 106–114, 116–119) gives the following account of his discovery and observations:†

> At San Francisco, as early as April, I saw large numbers of viviparous fish in the market for sale; but then it is an open question whether these fish really arrive at an earlier period of the year in the Bay of San Francisco than at Vancouver Island. I think not. That they are taken earlier in the year is simply due to the fact that the fishermen at San Francisco have better nets and fish in deeper water than the Indians, and consequently take the fish earlier. The habit of the fish is clearly to come into shallow water when the period arrives for producing its live young; and from the fact that some of these fish are occasionally taken at all periods of the year, I am induced to believe that they do not in reality migrate, but only retire into deeper water along the coast, there to remain during the winter months, reappearing in the shallow bays and estuaries in June and July, or perhaps earlier, for reproductive purposes; here they remain until September, and then entirely disappear.

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* Prof. Ryder has already shown that this observation is erroneous.

† For this account I am indebted to Dr. Theodore Gill.

They swim close to the surface in immense shoals, and numbers are very craftily taken by the Indians, who literally frighten the fish into their canoes. At low tide, when a shoal of fish is in the bay or up one of these large inlets that intersect the coast line, the savages get the fish between the banks (or the rocks, as it may be) and the canoe, and then paddle with all their might and main among the terror-stricken fish, lashing the sea with their paddles and uttering the most fiendish yells. Out leap the fish from the water, in their panic to escape this (to their affrighted senses) terrible monster; and if not out of the "frying pan into the fire," it is out of the sea into the canoes—which in the long run I take to be pretty much the same thing.

It appears to be a singular trait in the character of viviparous fish, that of leaping high out of the water on the slightest alarm. I have often seen them jump into my boat when rowing through a shoal, which is certainly most accommodating. The Indians also spear them; they use a long, slender shaft with four barbed points, arranged in a circle, but bent so as to make them stand at a considerable distance from each other. With this spear they strike into a shoal of fish, and generally impale three or four; many are caught with hooks, but they bite shily, the only baits I have seen taken being salmon roe nearly putrid, or bits of crab.

Just prior to my leaving Vancouver Island, numbers were netted by Italian fishermen who had a seine. They found a ready sale for them in the market, but as a table dainty they are scarcely worth eating; the flesh is insipid, watery, and flabby, and I am convinced that no system of cooking or culinary skill would ever convert it into a palatable fish.

The geographical range of viviparous fish, as far as I have any opportunity of judging, is from the Bay of San Francisco to Sitka. It may, perhaps (and I have but little doubt that it does), extend much farther south along the Mexican coast; but this I can only surmise, never having seen them beyond the limits above stated. It frequents all the bays and harbors on the east and west sides of Vancouver Island, and is equally abundant in the Gulf of Georgia and the Straits of Juan de Fuca; making its appearance about the same period, or perhaps somewhat earlier, in the various inlets on the Oregon coast, from Cape Flattery to the Bay of San Francisco. It will be just as well, perhaps, before I go into the subject of its specific characters and singular reproductive organs, I should mention how I first stumbled upon the fact of its being viviparous.

Soon after I arrived at Vancouver Island, I at once set to work to investigate, as far as it lay in my power, the habits and periods of migration of the different species of fish periodically visiting the Northwest coast. The sole means then at my disposal to obtain fish for examination, or as specimens to send home, was to employ Indians or catch them myself; so it happened, some of these were first brought me by Indians. Cutting one down the side (the plan I usually adopt to skin a fish, keeping the opposite side untouched), to my intense surprise, out tumbled a lot of little fish. My wildest dreams had never led me to suppose a fish I then thought was a bream, or one of the perch family, could be viviparous. I at once most hastily arrived at the conclusion that the greedy gourmand had eaten them; dropping my knife, I sat in a most bewildered state looking at the fish.

The first ray of light that shone to illumine my mystification seemed to spring from the fact that each little fish was the model, counterpart, and facsimile of the larger, and in shape, size, and color were exactly alike; from the position, too, they occupied in the abdomen of the larger fish, I was led at once to see the error of my first assumption, that they had been swallowed. Carefully dissecting back the walls of the abdomen, I discovered a delicate membranous bag or sac having an attachment to the upper or dorsal region, and doubled upon itself into numerous folds or plaits, and between each of these folds was neatly packed away a little fish; the bag was of bluish-white color, and contained fourteen fish. I had no longer any doubt that the fish was viviparous, and that it was a true and normal case of ovarian gestation. So much for my first discovery; the details of my subsequent examinations I shall again have occasion to refer to. * * [Here is added an account of Jackson's discovery.]

I have spoken of this at some length, because it is a curious coincidence that the same fact should have been discovered by two men, a long distance apart, about the same date, and by both in the same way—by sheer accident.

Now we come to the ticklish question: How are the young fish vitalized in the abdomen of the mother? In this case I shall adopt what I conceive to be the most straightforward course, which is candidly to give my own thoughts, and solicit from abler, older, and better physiologists their opinions or theories, for I sincerely think this is a question well worth careful investigation. I believe the ovum, after impregnation, at first goes through the same transformations in the ovarium as it would do, supposing it to have been spawned and fecundated in the ordinary spawning-bed, but only up to a certain point; then, I think, the membrane enfolding the ova, that have by this time assumed a fish-like type, takes on the character and functions of a placental membrane, and the young fish are supplied by an umbilical cord, just as in the case of a fœtal mammal. But a third change takes place. There can be no doubt that the young fish I cut out, and that swam away, had breathed before they were freed from their mother; hence I am led to think that, a short time prior to the birth of the young, sea-water has access to this marsupial sac, washes over the infant fish, the gills assume their normal action, and the regular systemic circle is established. Maturity attained, the umbilical attachment snaps, and the little fish, perfect in every detail of its organization, is launched into the deep to brave its many perils and shift for itself. The strong transverse muscles attached to the powerful sphincter (constituting the genital opening acting from the abdominal walls), I imagine are in some way concerned in admitting the sea-water, and it appears a contrivance admirably adapted to effect such a purpose; but how impregnation takes place I may at once honestly confess—I do not know.[*]

The male is much like the female, but more slim, and the milt just like that of other fish. I can only conjecture that fecundation is accomplished through the medium of the sea-water, admitted by the curiously cell-contrived floodgate of the female, carrying in the milt-germs and washing them over the ova.

The actual period of utero-gestation I am by no means sure about, but I am inclined to think they breed twice in the year. It is worthy of remark that the young mature fish are very large, when compared with the size of the mother. In a female fish 11 inches in length, the young were 3 inches long, the adult fish 4½ inches high, the young an inch.

* * * * * * * * * *

But now for the most important feature in the history of these fish—that of bringing into the world their young alive, self-dependent, and self-supporting, as perfect in their minutest organization as the parent fish that gives them birth. The generative apparatus of the female fish when in a gravid state may be defined as a large bag or sac. Ramifying over its surface may be seen a most complicated and strangely beautiful vascular arrangement—a network of vessels, the use of which is clearly to convey the life-giving fluid to the infant fish, and carry it back again, after having served its destined purpose, to be revivified for future use. The way the sac is, as it were, folded, and the different compartments made for the accommodation of embryonic fish, is most singular, and very difficult to describe clearly.

The best illustration I can think of is an orange. You must imagine the orange divided into its regular number of little wedged-shaped pieces, and each to represent a fish; that the rind of the orange is a delicate membrane, having a globular shape, and easily compressed or folded. You now desire to fit the pieces together again in the original orange-shape, but you must begin on the outside of the globular membrane, pressing in with each section a fold of the membrane (remember that each represents a fish); when each piece is in its place, you will still have the sac in its rounded form, but the rind or membrane has been folded in with different pieces. If I have made myself understood, it will be seen that there must be a double fold of membrane for each portion of orange. This is exactly the way the fish are packed in this novel placental sac. If it were practicable to remove each fish from its space, and the sac retain its normal shape, there would be twelve or fourteen openings (depending upon the number of young fish), the wall of each division being a double fold of membrane, the double edges wrapping or, as it were, folding over the fish. Now make a hole in the end of this folded bag, and *blow* it full of air, and you get at once the globe-shaped membranous sac I have likened to an orange.

The fish are always arranged to economize space; when the head of a young fish points to the head of its mother, the next to it is reversed, and looks towards the tail. I am quite convinced that the young fish are packed away by doubling or folding the sac in the same way I have endeavored to describe. I have again and again dissected out this ovarian bag, filled with fish in various stages of development, and floating it in salt water, have, with a fine pointed needle, opened the edges of the double membranous divisions that enwrap the fish (the amount overlapping is of course greater when the fish is in its earlier stages of development). On separating the edges of the sac, out the little fishes pop. I have obtained them in all stages of their growth, but sometimes (and this not once or twice, but often) have set free the young fish from its dead mother. Thus prematurely cut loose from its membranous prison, the infant captive, reveling in its newly-acquired liberty, swam about in the salt water, active, brisk, and jolly, in every particular, as well able to take care and provide for itself as its parent. The female external genital opening is situated a little posterior to the anal opening, the orifice is at its apex, and in the center of a fleshy conical protuberance, which is in fact a powerful sphincter muscle, *moored*, as it were, in its place by two strong muscular ropes, acting from and attached to the walls of the abdomen.

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[*] It is perhaps needless to state that the above paragraph is far from stating what does take place.

The above account by Lord, as far as it deals with the embryology, is largely conjecture and of no value. It is here given simply to complete the history of the work done on these fishes.

James Blake, Proc. Cal. Acad. Nat. Sci., III, 314–317, gives somewhat more reliable information. His paper is given in full:

I am not aware that the process by which the embryo of the Embiotocoid fishes receive the nourishment necessary for its growth, has ever been pointed out. It certainly differs from the three most common forms in which the embryo of other animals is nourished, as there is nothing like a placenta by which they can receive nourishment from the mother; there is no supply of nutriment surrounding the embryo as in the case of most oviparous animals, nor is the embryo brought into direct contact with the water, so as to derive nourishment by absorption from the surrounding medium, as is the case in oviparous fishes generally and in most of the lower forms of animal life. The young fish is contained in a uterus which, in the undeveloped state, resembles very much the ovaries of the common oviparous fishes, except that its walls are thicker, and that the number of ova it contains is very much smaller. In the interior of the uterus, projecting from its sides, are a number of processes analogous to those to which the ova are usually attached. These processes vary in number in different examples, but they are so arranged that each fœtal fish is in contact on every side with a surface of one of these processes. They consist apparently of a membrane composed of a cellular tissue, and scattered over their surface are a number of small mammillary elevations with an orifice in the center, and which are probably the organs by which the peculiar secretion of the uterus, to be hereafter noted, is poured out.

In an example I examined, in which impregnation had apparently just taken place, numerous ova were found adhering to these processes, although not at all in such numbers as in the ordinary fishes. I counted thirty-eight in about the space of an inch; of these, however, but few can be developed, as the number of fœtuses seldom exceeds forty, and is sometimes only eight. In the whole of the uterus there probably were from one hundred to one hundred and fifty ova. Of the earlier stages of development, however, it is not my object to treat in the present memoir, as I did not commence my investigation sufficiently early to be able to fully make it out; as soon, however, as the embryo has advanced sufficiently for the fins to be formed, these appendages are found to be terminated by a number of digitations, which project from the free edges of the fin, and are usually found situated one between each ray or spine. They are composed almost entirely of fine capillary blood-vessels, united apparently by a very delicate and structureless membrane. They are so delicate that unless great care is taken in removing the specimen from the uterus, they are destroyed; nor have I ever been able to discover them in specimens that have been preserved in alcohol. These processes seem continuous with the membrane extended between the rays of the fins, but are much more delicate; they project from the free edge of the fin, sometimes as much as the eighth of an inch, and are, in the fully developed embryo, the fifteenth of an inch broad. On the free margin of each digitation, a larger capillary can be observed, which appears to be continuous all around; it is about the .003 inch in diameter, the intermediate space being filled with a network of smaller capillaries. This system of digitations projects from the entire edge of the dorsal, ventral, and caudal fins, but not from the pectorals. They in fact form a fringe around the entire body with the exception of the head and that part of the abdomen in front of the anus.

Such is the structure of the organ that evidently has some connection with the fœtus, resembling as it does so closely the early formation of the vascular villi and the placental tufts that proceed from the chorion of the mammiferous embryo, and through which it derives its nourishment before the placenta is fully formed.

The question now presents itself as to how nourishment is conveyed from the parent to the fœtus through these tufts? As before stated, the lining membrane of the uterus sends off processes which surround each fœtus, without however forming shut sacks; but although these processes are very freely supplied with blood-vessels, yet the finest injection failed to show any more vascular spots where the fœtal digitations might have been brought into more immediate contact with the blood of the parent. I however was fortunate enough to obtain a fish, in the uterus of which I discovered a considerable quantity of fluid, and on collecting it and submitting it to chemical tests, I found that this fluid contained a considerable quantity of animal substance, resembling, to a certain extent, some of the compounds that are formed from albumen during the progress of digestion. The fluid was of yellowish color, translucent, deposited on standing some small globules which under the microscope strongly refracted the light, were not altered by acetic acid, but dissolved in ether; probably fat globules; when heated there was no coagulation, although the fluid was not quite so clear; solution of $HgCl_2$, caused no precipitate; tannin in solution caused a yellowish precipitate. In adding ether to a portion of the fluid, there was a free disengagement of gas, a white flocculent precipitate was formed, and on allowing the vessel to stand the fluid separated itself into three portions: the upper portion consisting of pure ether apparently, then a layer containing white flocculi, which occupied about the fourth part of the fluid, and below this the remains of the original fluid, but little altered in appearance. There can, I think, be little doubt but that it is through the medium of this fluid that the fœtus obtains its nourishment. The considerable portion of animal matter it contains, and that too in a state particularly fitted for absorption and for conversion into tissue, fits it for furnishing the fœtus with the elements necessary for its growth by absorption through the large surface of capillary vessels which are found in the vascular digitations that surround the fœtus, and which are constantly bathed in the fluid. The difficulty that up to the present time has attended every attempt to trace the connection between the parent and fœtus in these embiotocoid fishes is owing, in the first place, to the extreme delicacy of the vascular digitations of the fœtus, which prevents their being observed in preserved specimens, and also to the fact that in almost every case the fluid secreted by the uterus is entirely expelled by the violent struggles of the fish when removed from the water, so that it was almost by a rare accident that I succeeded in obtaining any. I hope, however, during the coming season to be able more fully to carry out these researches. (San Francisco, January 21, 1867.)

Later he published the following note, v, 371–372:

Some months since I presented a communication to the Academy pointing out the manner in which the fœtus of the embiotocoid fishes was nourished whilst it was being developed within the ovisac. I there stated that the ingress of water into the ovisac would not take place at all freely, as the organ communicated with the surface by a narrow canal surrounded by muscular fibres. This structure of the oviduct would evidently oppose an obstacle to the entrance of the semen into the ovisac for the purpose of impregnation, unless some means exist by which the ventral surfaces of the fish can be maintained in contact during the act of copulation, as the penis consists of a slightly developed tubercle which can not penetrate for any distance into the oviduct. From the direction of the orifices of the penis and oviduct it is evident that anything like a perfect contact of these organs can only be maintained whilst the fishes are in a reversed position, so that the head of one fish is towards the tail of the other. In order that contact may be maintained whilst in this position, we find the anal fin of the male fish furnished with certain appendages which enable it to give a firm hold to the ventral fins of the female, so that close contact of the ventral surfaces can be maintained.

These appendages are of two kinds. In *Embiotoca*, *Damalichthys*, and some other genera we find a well-developed mammary elevation situated near the anterior part of the anal fin on both sides, terminating in front by a teat-like process. In *Amphistichus*, *Holconotus*, and some other genera this mammary appendage is wanting; but its place is supplied by a bony transverse plate with serrated edges, inserted in the fin some distance farther back and parallel to the fin rays. In addition to these plates there are also found cartilaginous ridges with roughened borders, placed in front of the plates and running parallel with the edge of the fin. I think there can be no doubt but that these fin appendages serve the purpose I have assigned to them, for on placing the fish in the reversed position, with the orifice of the oviduct and penis in contact, it will be seen that they enable the ventral fins of the female to secure a firm hold on the anal fin of the male, so as to keep the fish in contact during the process of copulation. At the season of copulation the anterior surface of the anal fin in the male becomes covered with a thick layer of firm epithelium. As this commences at a short distance from the ventral attachment of the fin, a well-marked groove is formed at the base of the fin, which affords an additional hold for the ventral fin of the female. After the season of copulation is over and the testicles regain their quiescent state, this epithelium almost disappears. At the same time the mammary sack diminishes very much in size, so that when the testicles are reduced to their smallest size hardly a trace of the sack remains. One or the other of these forms of appendages have been found on the anal fin of the male in all the species of embiotocoid fishes I have examined.

Prof. Ryder (1885) discovered that what had been taken for a yolk bag by Girard was a projection of the abdominal profile, caused by the hypertrophied hind gut, and that the inner lumen of the hind gut is filled with "villi of the most extraordinary length. * * If extended, some of these villi would more than reach across the lumen of the intestines." Since no such structure is found in the adult he thinks it "obvious that this hypertrophy of the hind-gut and remarkable development of elongated villi in the embryos of the surf perches has some important function to subserve during fœtal life." This function he considers to be the digestion of the fluids secreted by the walls of the "ovarian sack."

Ryder studied material collected by Rosa Smith at San Diego, and from the date at which this material was taken he concludes "that during the months of October and November one would probably find the earlier stages, which are so desirable to clear up what must evidently be a most interesting chapter in vertebrate embryology." He redescribes the highly vascular larval fins, and adds that all of the vascular digitations at the edges of the vertical fins receive their blood supply from the median aortic trunk, which reaches them through trunks given off from the aorta at irregular intervals of one, two, or even six muscular segments. At the base of the fins they subdivide into from two to six branches, which pass up a little to one edge of the interradial space, giving off smaller trunks to the highly vascular interradial membrane and ending in a flat sieve-like capillary mesh. The vascular trunks do not correspond to the number of rays, a fact which indicates "that this singular vascular supply of the vertical fins of embiotocoid embryos has attained great specialization and must be of very great physiological importance."

He further describes the peculiar vascular supply of the caudal and of the skin. He finds that nothing is found in the adult which corresponds to this larval condition. All this arrangement he considers to be for the purpose of respiration and not for the purpose of absorbing nutriment from the ovarian space, as Dr. Blake supposed.

As will be seen later, I consider that both these functions are in part subserved by this highly specialized vascular system.

I have published several notes on the eggs and development of the *Embiotocidæ*, but since these observations will be extended and corrected in the following pages, it is not necessary to mention them further here.

CYMATOGASTER AGGREGATUS Gibbons.

Cymatogaster aggregatus is probably the most abundant species of the *Embiotocidæ*, and is found along the entire western coast of the United States and part of Lower California.

Breeding habits.—During the summer and fall this species is rarely seen, as it then probably lives a short distance off shore in deep water or among fields of *Zostera*. In November and December it approaches the shore in large numbers, and is caught with hook and line off the wharves in San Diego and San Francisco bays. The greater part of the specimens so caught are females, there being rarely a male among them. This is probably due in part to the facts that the male is much smaller than the female and, farther, that this is not the period of copulation. The largest females become gravid about the first of December (one very large one was found with developing eggs on November 1, at San Francisco); by the middle and latter part of the same month the greater number of those taken are with eggs in various stages of development. During January the smaller ones caught are with developing eggs, while the smallest, those which do not take the hook and can only be procured with a seine, have eggs in similar stages during February.* The oldest are, as a rule, sexually ripe earlier in the season. The same variation of the time of maturation was observed in the other species of this family.

Methods of studying living eggs.—The fishes were kept alive in salt water until needed. The spinal cord was severed and the ovary immediately excised and brought entire on a glass slip. The ovary was then slit open and the oviferous sheets unfolded. If there were free eggs they were placed together near a fragment of the ovary and the whole covered with a glass slip. The eggs could thus be examined in their natural fluid, and I have succeeded in keeping them alive for an hour. The oviferous sheets being very thin, a fragment of one could be spread out, covered and examined, fresh. In this way many stages of growth of the egg could be observed *in situ*. The ovaries containing embryos or larvæ are slightly translucent and, after some practice, can be distinguished from those not yet mature.*

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* TIME OF MATURATION AND SIZE OF EGG OF OTHER SPECIES OF EMBIOTOCIDÆ.

Embiotoca jacksoni: The first one with eggs was noticed November 12 (1889). One of the eggs found at this time was in the two-cell stage, all were free from the follicle. The diameter of the egg membrane is about .7 mm., the smallest observed being .53 mm., the largest .92 mm. The diameter of the yolk is about .45 mm.

Amphistichus argenteus. Diameter of the egg membrane .65 to .68 mm.; yolk .441 to .49 mm.; oil-globules .14 mm.; green eggs near maturity .65 mm. The water space is therefore, as in *Cymatogaster*, formed by the contraction of the yolk during maturation.

The specimens taken at San Diego, where I had an opportunity of examining large quantities, are of three sizes. The largest measure about 300 mm., the second in size 160 mm., and much smaller ones of variable sizes. There are, of course, intermediate sizes between the largest, 300 mm., and the second, 160 mm., but the groups are quite well marked. The largest have ripe eggs as early as November 12 (1889). The second in size have eggs near the middle of December. The following is from my notes, December 19, 1889: "A large number of individuals taken to-day, 160 mm. long; all have the eggs nearly equally developed. The germ is nearly at the close of segmentation; the eggs are still inclosed in the follicle. Only in one specimen were the eggs free. In these the gastrula covered the entire yolk. December 27 one female 160 mm. long was obtained; the embryo is hatched; the yolk is almost all absorbed. There is a continuous dorso-ventral fin-fold. These eggs, therefore, hatch in less than a week."

I did not determine the maturing period of the smallest individuals, but on December 10 I made the following note: "The smallest have eggs quite green."

On December 10 the largest contained young from 5 to 7 mm. long. The larvæ at the end of the first month would probably average 7 mm.

Methods of studying living larvæ.—The same process of procuring the larvæ is used as for obtaining the eggs. The very young are, however, much more difficult to see than the eggs, and it is frequently necessary to spread out the tissues and examine them microscopically before the larvæ can be found. It is to be borne in mind that in this species the maximum number of eggs maturing in a season is only 22, and since the eggs are minute it would frequently be difficult to determine whether an ovary was immature or contained young embryos if it were not for the slight difference in the ovary itself as mentioned before. In these earliest stages the larvæ are very sensitive to the condition of the mother. It has frequently happened that the larvæ have become distorted if the mother had been confined in a pail of water for half an hour and before she showed any signs of exhaustion. They are most sensitive when the circulation is just established, but are frequently found to be nearly dead after they have attained 20 mm. in length, if the mother has been confined in standing water for several hours. For many stages this fact is very useful, since the young can be thus stupefied and studied more readily. For the latest intraovarian stages this method again produces distortions and coagulations in the vessels of the fins before the young is sufficiently stupefied. Partly asphyxiated larvæ, 10 to 20 mm. long, can frequently be revived by simply placing them in some of the ovarian fluid on a glass slip, where they are exposed to the air. The method of removing a blood clot from the blood vessels can thus be observed very readily.

Connection of the developing egg and larva with the ovarian structures.—Part of the maturation processes of the egg are undergone in the follicle, but in all probability the egg is freed from the follicle before segmentation. Unsegmented eggs have been found free between the ovarian lamellæ. The larvæ always fall out of the lamellæ if the ovary is immersed in any preservative fluid, and in the older stages the young can be seen to change head for tail in the ovary, so it may be safely said that the eggs and young are, during no stage of their development, connected with any portion of the ovary. Sections of some stages of ovaries containing eggs and young tell the same story.

Position of larvæ in the ovary.—Girard stated that in some species the embryos were regularly arranged in the ovary and that in *Hysterocarpus traski* (1859, p. 16) in which the young were nearly ready to be born "all of them had their heads in the same direction as that of the mother, a circumstance for the first time noticed." That the larvæ are not definitely arranged in the species examined by me has already been mentioned and is emphasized by the fact that in later stages they can change their position.

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* It will be found to be more difficult to study the different stages of the developing egg of these fishes than pelagic eggs, or even mammalian eggs, because the age of the contained eggs can not be known, as in the case of mammals, and the different stages, if they are not incidentally procured, must, therefore, be sought by chance, a process which often necessitates the examination of many individuals and consumes much time. To add to the difficulty, the fishes, after heavy rains or a slight fall of temperature, seek deeper water and can not be procured. Stages thus lost had to be sought in the next series (smaller specimens) to mature—a process which did not always prove successful. To balance this, there is an almost unlimited supply of specimens when the conditions are favorable.

To show their position in the ovary I have tabulated the following series:

Total No. of young.	Size.	No. in ovarian sacks.	No. between ovarian sacks and ovarian walls.	Axis corresponding to that of mother.	Axis reversed to that of mother.
11	18 mm.	3	8	8	3
14	21	6	8	6	8
12	20	4	8	3	9
11	....	6	5	6	5
17	40	....	....	16	1
14	14	....	....	10	4
10	32	....	....	7	3
12	18	....	....	5	7

From this it is evident that there is no definite arrangement of the larvæ as far as the ovarian sack is concerned, and scarcely any as far as the axis of the embryo is concerned, but the condition indicated by the larvæ 40 mm. long in the above list is repeated in all the largest larvæ. That is, when they approach the period of extrusion they come to lie with their heads forward. This may be due to the fact that the gills being now well formed the heads of the larvæ are turned to the origin of the oxygenated blood supply, which is at the anterior end of the ovary.

Intraovarian food.—The yolk, both on account of its small size and because it is not absorbed until very late, is evidently not sufficient to account for the growth of the embryo and larva. It disappears months before the intraovarian development is complete. There is probably general surface absorption through the whole of the ovarian life and, as we shall see, there is evidently intracellular digestion in the epidermal cells in the eggs. The yolk is scarcely if at all diminished before the zona bursts, and yet growth is so rapid that the mere size of the embryo bursts the zona long before any movements are evident on the part of the young. This process of absorption by the general surface practically supplies all the food until the first gill-slit is open.

With the opening of the first gill-slit a new process begins—the absorption by the intestinal canal. Before the mouth is opened a continuous stream of the fluid contents of the ovary enters the first gill-cleft, and passes apparently unchanged through the anus. This process can frequently be observed.

This continuous stream is due to the presence of cilia in the intestinal tract. The blood corpuscles and solid particles of the ovarian fluid seem to get into small whirlpools if they approach the side of the tract. Part of this may be due to the presence of spermatozoa, which frequently fasten themselves in clusters on the inner surface of the intestinal tract while their tails are kept in active vibration. The spermatozoa remain in the ovary during several weeks of gestation.

In one individual the stream into the gill-cleft was especially noticeable, as the stream contained many blood corpuscles which had been freed when the ovary was slit open and a large number of highly active spermatozoa. With the opening of the mouth long villi appear in the hind gut, and the process of digestion proper is established. Soon after this the spermatozoa disappear from the ovarian fluid, being in all probability digested in the hind gut. Succeeding the opening of the mouth, a solid mass of substance is frequently found in the intestines, which is composed of the solid particles of the ovarian fluid and which in part is composed of these spermatozoa.*

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* In my first notice of this fish I did not know the meaning of the mass nor did I then know that food is taken in through the hyomandibular slit before the mouth is open.

As I have stated before, food absorption is probably continued by parts of the general surface throughout intraovarian existence, and is greatly facilitated in later stages by the highly vascular fins.

The food absorbed and digested is furnished by the ovarian lamellæ themselves. These structures are much greater than is necessary to bear the few eggs, and they are so constructed that they offer the greatest uninterrupted surface possible.

The intraovarian food entering the intestines consists in great part of solid cell-like particles. These are found both in the gravid ovary and in the intestine of the embryo. They, together with the ovarian fluid, are the product of the lining epithelium. The individual cells of this structure become distended with an unstainable fluid. At the outer margin of these distended cells are seen nucleated bodies in all stages of separation from the epithelium. At first I supposed them to be the product of the epithelial cells, but am more inclined now to consider them the cells themselves deprived of their fluid contents. These cells are found in the intestine of the larvæ, in early stages, few in number, in later stages forming a solid mass.

The amount of fluid in the ovary at any time is very small in *C. aggregatus*, but is very much greater in some other species. Till the young has attained a length of several millimeters there is no more of it than there is serum in the body cavity. In the later stages, when the lamellæ are stretched to their utmost and the highly vascular surface of the fins is brought in contact with them, direct dialysis, primarily for oxygenation, probably takes place between the cells of the ovarian lamellæ and those of the young.

Intraovarian respiration.—That there is the closest intimacy between the respiration of the mother and young has been proved by the fact that the latter shows signs of asphyxiation before the former shows exhaustion, *i. e.*, if the mother is kept in stale water; if she is taken from the water she will die before the young. The embryo and larvæ are at all times in contact with the structures of the ovary which derive their blood directly from the gills. During the early stages the highly active spermatozoa keep the ovarian fluid in circulation and thus help the ciliated lining of the intestine of the larva to bring oxygenated albumen from distant parts of the ovary; while later the highly vascular fins and general surface of the body are in direct contact with the ovarian sheets. As the body becomes covered with scales the surface of the fins increases. It has already been stated that partly asphyxiated young can readily be revived by exposing them to the air in some of the ovarian fluid, a fact which seems to demonstrate the affinity of this fluid for oxygen. Respiration is probably also carried on through the stream of ovarian fluid flowing through the intestine, as Stuhlmann has suggested for *Zoarces*. The young, unless they have nearly reached maturity, invariably die if they are placed in either fresh or salt water.

Duration of gestation and adolescence, and number of young.—The exact date at which the young are set free I am not able to tell. Some are freed as early as April, while others are not freed till June. The probable duration of gestation, counting from December 1 to May 1, is five months. The following February the smallest individuals are sexually mature. The time from the birth of one generation to the beginning of the next is therefore about ten months. Usually all the eggs in an ovary are equally developed; only rarely was any marked difference observed. In one case one young was apparently four weeks older than the others.

Malformations are rare. Double-headed monsters or similar forms have never been seen. In one case the lower jaw was distorted; in another one eye was destroyed; in fact all the malformations found were evidently due to causes acting after hatching, overcrowding, etc., and entirely different in kind from those producing double monsters. Nonfertilized eggs were not found unless the single dead egg found among all of those examined died because of nonfertilization. It is of course not to be expected that any eggs should escape fertilization when they are permanently surrounded by a fluid highly favorable to the longevity of spermatozoa.

The following table will enable us to form some estimate of the number of young and the rate of growth. Most of the individuals obtained during one season are recorded. It must be borne in mind, however, that no small mothers were obtained in the early part of this season. Some valuable embryos and larvæ can not be recorded here because I could neither beg nor buy the mothers and secured the young only by offering to clean the fish for the captor.

The first column gives the ovaries in the numerical order in which they were procured. The headings sufficiently explain the remaining columns.

No.	Date.	Length of mother.	Condition of young.	Number of young.
	1890.	*mm.*		
1	Nov. 1	160	1 to 8 cells	18
2	Nov. 30	140	36 (?) cells	21
3	Nov. 30	150		
4	Nov. 30	120	About complete segmentation.	
5	Dec. 15	106	Not ripe	
6	Dec. 15	106	Complete segmentation.	9
7	Dec. 15	137		13
8	Dec. 15	150		
9	Dec. 18	105	Complete segmentation.	10
10	Dec. 18	120	Not ripe	
11	Dec. 18	135	Just hatched	11
12	Dec. 18	125	Not ripe	
13	Dec. 18	125		15
14	Dec. 18	135		16
15	Dec. 23	150	5 mm	17
16	Dec. 23	150	8th segment (?)	10
17	Dec. 23	140	Yolk inclosed	14
18	Dec. 23	135	......do	10
19	Dec. 28	110		7
20	Dec. 28	98	Not ripe	(5 eggs)
21	Dec. 28	103		6
22	Dec. 28	140		19
	1891.			
23	Jan. 1	135	4 eggs ripe	
24	Jan. 1	122	Blastopore closing	11
25	Jan. 1	140	7 mm	
26	Jan. 1	110		16
27	Jan. 1	140	Not ripe	
28	Jan. 1	130, 140	Hatched	
29	Jan. 1	140	Just hatched	
30	Jan. 1	120		
31	Jan. 1	130	No protovertebræ	13
32	Jan. 1	115		13
33	Jan. 1	140	6 mm	11
34	Jan. 1	145	12 mm	
35	Jan. 1	140	6 mm	
36	Jan. 1	120	2.6 mm	
37	Jan. 1	140	4 mm	
38	Jan. 1	145	8 mm	
39	Jan. 4	110	Segmenting	7
40	Jan. 4	115	Segmenting	10
41	Jan. 4	110	Segmenting	8
42	Jan. 4	140	3 mm	19
43	Jan. 4	115	2 mm	12
44	Jan. 4	112	Segmenting	
	1891.	*mm.*		
45	Jan. 4	120	Not ripe	
46	Jan. 4	145	12 mm	20
47	Jan. 8	125	5 mm	7
48	Jan. 8	120	Just hatched	11
49	Jan. 8	122	Segmenting	14
50	Jan. 8	124	Segmenting	13
51	Jan. 8	144	6 mm	17
52	Jan. 8	140	6 mm	18
53	Jan. 8	138	5 mm	22
54	Jan. 8	137	5½ mm	16
55	Jan. 8	120	Segmenting	12
56	Jan. 8	121	Segmenting	(?)
57	Jan. 11	155	6–11 mm	17
58	Jan. 11	120	Hatched	
59	Jan. 11	118	Segmenting	7
60	Jan. 11	134	2.5 mm	9
61	Jan. 11	133		
62	Jan. 11	135		
63	Jan. 11	140		
64	Jan. 21	145	7 mm	
65	Jan. 21	155	5½ mm	17
66	Jan. 25	165	6 mm	20
67	Jan. 25	147	7 mm	18
68	Jan. 25	162	15 mm	15
69	Jan. 25	120	5 mm	9
70	Jan. 25	112	2 mm	
71	Jan. 25	145	2 mm	
72	Jan. 25	120	2 mm	
73	Apr. 19	80	6 mm	6
74	Apr. 19	85	4 mm	7
75	Apr. 19	100	14 mm	8
76	Apr. 24	110	10 mm	9
77	May 24	160	Empty. Ovary still very large.	
78	May 24	140	....do	
79	May 24	150	Empty. Ovary reduced to normal.	
80	May 24	120	Empty. Ovary reduced to normal.	
81	May 24	100	18 mm	5
82	May 31	118	25 mm	8
83	May 31	112	22 mm	8
84	May 31	107	22 mm	7
85	May 31	100	20 mm	6
86	May 31	100	22 mm	5
87	May 31	90	Not mature	
88	May 31	100	20 mm	6
89–95	May 31		♂ with large testes	

These lists, arranged according to the size of the parent, give the following results:

Date.	Length of mother.	Condition of young.	Number.	Date.	Length of mother.	Condition of young.	Number.
1890.	*mm.*			1891.	*mm.*		
Nov. 1	160	1 to 8 cells	18	Jan. 21	155	5½ mm	17
Dec. 23	150	5 mm	17	25	165	6 mm	20
23	150	Eighth segmentation	10(?)	25	162	15 mm	15
1891.				May 24	160	Just born	
Jan. 11	155	6 to 11 mm	17	24	150	Born some time	

Average number of young, about 16. Duration of gestation, about 5 months.

1890.				1891.			
Nov. 30	140	36 cells	21	Jan. 1	145	12 mm	
Dec. 15	137		13	1	140	6 mm	
18	135	Just hatched	11	1	140	4 mm	
18	135		16	1	145	8 mm	
23	140	Yolk inclosed	14	4	140	3 mm	19
23	135	do	10	4	145	12 mm	20
28	140		19	8	140	6 mm	18
				8	138	5 mm	22
1891.				8	137	5½ mm	16
Jan. 1	135	4 ripe eggs		11	134	2.5 mm	9
1	140	7 mm		21	145	7 mm	
1	140	Not ripe		25	147	7 mm	18
1	140	Just hatched		25	145	2 mm	
1	140	6 mm	11	May 24	140	Just born	

Average number of young, about 16. Duration of gestation, about 5 months.

1890.				1891.			
Nov. 30	120	Segmentation about complete		Jan. 8	120	Just hatched	11
				8	122	Segmenting	14
Dec. 18	120	Not ripe		8	124	do	13
18	125	Not ripe		8	120	do	12
18	125		15	8	121	do	
22	122	Blastopore closing	11	11	120	Hatched	
1891.				25	120	5 mm	9
Jan. 1	120	2.6 mm		25	120	2 mm	
8	125	5 mm	7	May 24	120	Born some time	

Average number of young, about 11½. Length of gestation (longest possible time, 6 months 24 days; shortest, 4 months 16 days), about 5 months.

1890.				1891.			
Dec. 15	106	Segmentation complete		Jan. 11	118	Segmenting	7
			9	25	120	5 mm	9
18	105	do	10	25	112	2 mm	
28	110		7	Apr. 19	100	14 mm	8
28	103		6	24	110	1 mm	9
1891.				May 24	100	18 mm	5
Jan. 1	115		13	31	118	25 mm	8
4	110	Segmenting	7	31	112	22 mm	8
4	115	do	10	31	107	do	7
4	110	do	8	31	100	20 mm	6
4	115	2 mm	12	31	100	22 mm	5
4	112	Segmenting		31	100	20 mm	6

Average number of young, about 8. Duration of gestation, somewhat over 5 months.

1891.				1891.			
Apr. 19	80	6 mm	6	May 31	90	Not mature	
19	85	4 mm	7				

From these lists the fact mentioned before, that the larger individuals are with ripe eggs earlier than the small, becomes quite evident.

The very largest, 150 to 160 mm., have ripe eggs as early as November 1.

Those from 120 to 140 mm. have ripe eggs by November 30 or about December 1.

Those from 100 to 120 mm. have ripe eggs from December 15 to January 1.

These observations were taken at San Francisco. At San Diego, 500 miles farther south, I have taken the very smallest, less than 100 mm., with ripe eggs, March 3, 1889, and segmenting eggs could be obtained throughout January.

No definite time can, of course, be set for the maturation of the different sizes, because there is considerable variation even within small limits of size. This may again be due to the age of the fish. The age of the fish would be partly indicated by its size, but two fish of the same size may not necessarily be of the same age, since the rate of growth is in all probability not uniform in different individuals.

What I have endeavored to show for *Cymatogaster* is much more evident for *Amphistichus*, where there does not seem to be so much gradation in size, but several distinct sizes can be separated. These different sizes have also distinct maturation periods. It is also quite evident from these lists, and scarcely needs mention, that the number of young is directly proportional to the size. I obtained very minute mothers at San Diego with but three young, while, as is evident from the above, the average number for the largest mothers is 16, the maximum number observed by me being 22.

The ovary.—The ovary is a spindle-shaped bag, divided anteriorly into two arms which indicate the bilateral origin of the present structure. One of these arms, the left, is usually much smaller than the other, and the blood vessel entering the ovary by this smaller horn is also much smaller than that of the other horn. The testes of the right and left side are distinct. The ovaries of the two sides have evidently been united from behind forward, so that externally only the two anterior horns show the bilateral structure, and one of these horns seems to be in process of phylogenetic resorption. From the inner upper margin of this bag are suspended two sacks with their open ends near the posterior end of the bag. Each one of these sacks is divided by a vertical partition similar to their sides into two compartments.

The ovary lies, in the normal condition, just above the rectum and is suspended from the dorsal wall of the abdomen by a mesoarium which is directly continued below the ovary as the mesorectum.

The ovarian walls are composed, first, of the thin peritoneal membrane; second, of a layer of longitudinal muscle fibers; third, of a layer of circular muscle fibers, inside of which there is, in places, another layer of longitudinal fibers; fourth, of a very thin layer of cells with flattened, deeply stainable nuclei; fifth, of a layer of epithelium. This layer is derived from the peritoneum. The cavity of the ovary arises as a groove on the outer lateral portion of the germinal ridge. The raised margins of the groove unite and form the ovarian cavity, which remains for some time connected with the body cavity by a ciliated opening. The inner linings of the ovary are thus of peritoneal origin. Laterally and ventrally the two inner layers form simple thin linings; dorsally they are thrown up into a number of low ridges. Besides these ridges there are on either side of the median dorsal line three broad sheets which are simply ridges enormously exaggerated. These sheets are united to form the sacks mentioned above. Cross-sections of these sheets show them to be composed externally of a continuation of the epithelium lining the ovarian sheath and internally by a continuation of the membranous tissue lying immediately outside the lining epithelium of the ovarian walls. In other words, Nos. 4 and 5 of the structures enumerated above are raised and greatly prolonged to form these sheets. Ventrally the three sheets of each side have become united. The inner layers of these sheets sometimes form a solid tissue, but frequently they are well separated or connected by occasional fibers only. The latter is probably an artificial condition.

The blood vessels found in the sheets lie between the two inner layers of cells and are surrounded by tissues derived exclusively from the ovarian *walls*. They are always quite distinct from the surrounding tissues.

At a glance the conditions appear quite different from those obtaining ordinarily in fishes, but a closer inspection shows the chief difference to lie in the nonformation of numerous eggs and of a large amount of yolk. If the oviferous sheets of *Perca*, for instance, should be deprived of all but a few eggs they would be similar to those in *Cymatogaster*. The difference between them would lie in the size of the cells. The minute structure of the ovary will be more fully dealt with in a later part of this work, when the growth of the ovarian eggs is considered.

The blood supply* is derived from two vessels entering the two horns of the ovary. These are divided up in the front end of the ovary and traverse the ovarian sheets like the rays of a fan.

Secondary sexual characters in Cymatogaster.—1. The male is much smaller than the female; the latter reaches a length of about 160mm., while 120mm. is the length of the longest male recorded (figs. 180*a*, *b*).

2. The anal fin of the female is normal. In the male there is a slight depression on either side at the base of the anterior anal rays and the rays themselves are provided with a gland-like structure with a free duct pointing forward (fig. 108 *b*).

3. The median region of the belly in the male is naked. The anus (which is reached by the tips of the ventrals) is succeeded by a broad, low, blunt papilla, behind which lies a deep pit. In the female the papilla gives place to a circular opening of the oviduct.

4. The male is much darker than the female. Each row of scales is provided with series of pigment spots which form lateral bands. Dorsally the pigment spots sometimes become so numerous as to give the fish a black appearance. There is also a conspicuous black spot on the preorbital.

In the female the ventral regions, belly, and breast are free from pigment and the cheeks and lower parts of the head are also but sparingly pigmented. The lateral bands of dark are quite inconspicuous except in three vertical bars on the sides of the abdomen. In other regions they are overlaid by a golden tinge. The preorbital spot is either absent or inconspicuous.

Copulation.—The act of copulation has never been observed in the *Embiotocidæ*. Blake suggested that the ventral surfaces are appressed, the heads of the fish pointing in opposite directions. Ford supposes that "fecundation is accomplished through the medium of the sea water." It has lately been shown that contacts of the genital openings is not necessary for the transference of spermatozoa to the cloaca of *Diemyctelus*. The same may be true for *Cymatogaster*.

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* In *Amphistichus* the ovarian sheets are not united below, but hang free, and the blood supply, instead of being derived from vessels radiating from the anterior end, are derived from a vessel running along the dorsal part of the ovary.

Copulation takes place in Cymatogaster during June or early July, although the eggs are not fertilized till the following December! This fact strongly bears out my opinion expressed in the American Naturalist (1890, p. 925), that the small size of the eggs of *Cymatogaster* is due to a hastening in the process of maturation, and the consequent nonformation of yolk. (See chapter on the egg and segmentation, p. 421.) The normal or former period for maturation of the oviparous ancestors of *Cymatogaster* very probably coincided with the present time of copulation, or nearly with the present time of extrusion of the young; the eggs, however, which should be fertilized by these spermatozoa, have just been set free in the shape of living young. They, therefore, remain in the ovary in a dormant condition till the *next* series of eggs become mature, which they fertilize. It is difficult to imagine why the maturation of the male has not been similarly hastened with the hastening of the maturation period of the female, for the process must have been a gradual one. We must imagine a time when the result of the ovarian gestation was much less perfect than now, and the larvæ were freed in a much less mature stage than at present. Under such circumstances it would be quite possible for a number of spermatozoa to live through the period of gestation, and protract their stay in the ovary till other eggs were mature, and it is possible that the presence of spermatozoa may incite the eggs to the earliest maturation possible. If the eggs of a given season should be fertilized before the maturity of the males the spermatozoa introduced during the subsequent maturity of the males would necessarily remain in the ovary till the next series of ova were mature or else be destroyed. The hastening in the maturation of the ova of an oviparous fish would not be followed by the disastrous consequences to the offspring that would result in the too early maturation of an oviparous egg, and in the consequent reduced amount of food material, since the food necessary in the eggs of the oviparous fishes for their larval existence is supplied by the ovary.

It is in some such manner that we must explain the peculiar conditions existing in *Cymatogaster*.

Since the statement that copulation takes place about five months before the eggs are ready to be fertilized is somewhat paradoxical, it is perhaps best to state upon what facts I base this conclusion.*

During the period of segmentation few males are found with the females, which are then in shallow water, near wharves, etc. The testes of the males at this season are small and evidently during their period of physiological rest. The latter part of May I found a male with enormous testes, which I supposed to be in a pathological condition. Shortly afterward, May 31, 1891, I obtained in San Francisco a large number of males, all of which had enlarged testes, but none of which were mature. The males were now common in shallow water. The next lot of males was obtained nearly two months afterward, July 29, 1891, at San Diego. In these males the testes were nearly reduced to their resting condition again. On examining a large number of females at this same time (July 29) spermatozoa were found in all or nearly all the ovaries, *but the spermatozoa were inactive*, not showing a particle of their great mobility of December. Sections made through the entire length of the ovaries of this time showed large quantities of spermatozoa, extending between the ovarian sheets to the anterior end of the ovary, but especially abundant in the oviduct, just behind the ovarian sheets. Sections of ovaries of October and November also show spermatozoa, so that there is no doubt about the early transfer of spermatozoa.

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* This was written before Jordan's and Gage's papers on *Diemyctelus* appeared, from which it is evident that the spermatozoa can live a considerable time in the female *Diemyctelus*. A still more striking observation has been made by Bumpus in invertebrates. In the young lobster the transfer of spermatozoa may occur a year or even two years before fertilization takes place. I have not seen his paper and do not know whether Bumpus has demonstrated that the spermatozoa live from the time of the transference to the fecundation of the first lot of eggs or whether a new transference takes place

Development of ovarian eggs.—This subject, which properly belongs here, will be dealt with in a subsequent part of the paper when the development of the sexual organs themselves is described.

The mature egg.—I have not succeeded in keeping eggs alive for more than an hour after they were taken from the mother; and, in most cases, they perished after they had been removed from the ovary but a few minutes. The successive processes of segmentation and gastrulation could not therefore be observed. The methods could only be inferred from the different stages obtained from different individuals. Although I opened several hundred individuals, the series is not as complete as desired, because the individuals had to be opened when they were found, and there was no means of telling externally the length of time the contained eggs had been developing. In order to section developing eggs it is absolutely necessary to cut the zona. Many of the first eggs collected were not available for study because this was not done. The eggs are freed from the follicle before segmentation begins. In all probability fertilization takes place just before or just after they are freed. In a single case observed the second polar globule is being extruded and the male pronucleus is formed in an egg still inclosed in the follicle. The cells of the follicle show evident signs of degeneration. In other members of the family (*Amphistichus*) segmentation is carried on (to completion?) before the eggs become free from the follicle. In an ovary with eggs with two cells there were also found others with four and with eight cells.

The egg before it is freed from the follicle, measures on an average about 280 μ (sometimes more than 300 μ). During maturation the size of the egg proper is reduced to a diameter of 200 to 230 μ, or to half to one-third of its original volume. In this manner a considerable breathing chamber is formed within the zona which retains its original extension. If younger eggs are put under pressure a similar contraction sometimes takes place, leaving a space between the egg and the zona, which is traversed by a multitude of fine threads. That these green eggs can be made to contract by rupturing the zona probably indicates that the contraction of the ripe egg is due to the fact that at maturity the ovarian fluid gains access to the yolk on account of withdrawal of the granulosa cells from the zona. Similar reductions in the bulk of the yolk take place in other teleost eggs, as has been noted by several observers.

The mature egg, just before segmentation, is divided into two portions by a well-marked constriction. The larger of these and the one of an apparently homogeneous substance is the germ; the smaller, composed of very small spheres, the yolk spheres, is the *deutoplasm*. Situated in the middle point of the surface of the latter, or just at the entodermic pole of the egg, is a more homogeneous transparent mass sometimes containing one or two small spheres. The appearance of this structure is similar to the germinal vesicle and its nucleoli of the green egg, with the exception that its outlines are less regular, angles projecting in among the yolk spheres. A like structure has not been observed in any other egg (see under *yolk nucleus*, p. 423). The proportions of yolk and germ as found in other teleosts being reversed, at first glance the two structures might be taken for each other, and, indeed, I observed the yolk in a favorable egg for a considerable time, expecting it to show some signs of segmentation, before I became aware of the true state of affairs. The axis of the egg is slightly longer than the transverse diameters. The yolk, being the smaller segment of the sphere, is of a smaller diameter than the overlying germ.

Several eggs measured have the following dimensions in μ.

Total diameter from zona to zona.	Axis.	Diameter of germ.	Diameter of yolk.	Height of yolk.	Yolk nucleus.
300	276	258	230	98	
	231	213		89	
		249	179	53	36×45
244		200			

The proportion of the yolk is seen to vary considerably, as is also the size of the germ (200 to 258)—I did not look for extremes—all of which shows that the size of the egg of *Cymatogaster* is in a state of unstable equilibrium.

Intimately connected, of course, are the small size of the egg and the great reduction of deutoplasm. The nearest approach to the size of the egg of *Cymatogaster* is probably that of *Clupea*, in which the germ also has a comparatively large size. There are very few yolk spheres in the germ of *Cymatogaster*, so that the small amount of yolk present if evenly distributed in the germ would scarcely prevent it from undergoing complete and regular segmentation. As large a proportion of deutoplasm is probably found in some holoblastic eggs. The meroblastic condition of segmentation is here a purely ancestral trait. The small size of the yolk is unquestionably the result of viviparity and may have been brought about through natural selection. We need only hasten the time of maturation of the average teleostean egg by two or three months to produce an egg not unlike that of *Cymatogaster*, for, as I have shown elsewhere, the growth of the teleostean egg—*i. e.*, yolk formation—takes place *chiefly* during the two or three months before maturation. Should any eggs of an oviparous fish show any tendency to so early maturation the young would invariably perish during its larval stages, owing to the lack of food. Not so in a viviparous species. As will be seen later, in *Cymatogaster* intracellular digestion of the ovarian fluid takes place *before the embryo is freed from the zona*, which occurs very early. Eggs of such viviparous species with a tendency to early maturation, having all food necessary for their development in the surrounding liquid, would not necessarily perish, but would in fact have an advantage over eggs maturing later, which they could deprive of nourishment, if they did not feed on them. It would need but the hastening of the processes of maturation, as stated above, to produce an egg similar to that of *Cymatogaster*.

The teleostean ovary has a period of physiological rest and a period of great physiological activity, the latter in oviparous forms occupying the months just before oviposition. A hastening of the process of maturation and reduction of the number of eggs would therefore deprive viviparous forms of the type of the *Embiotocidæ* of their periods of greatest activity; but they are not deprived of this activity because the young, where only a few are born, remain for a long period in the ovary and are supplied by it with food during all that period. The period of gestation is the period of greatest activity—corresponding to the period of greatest growth of ova in oviparous species. The reduction of the yolk has taken place after the reduction of the number of eggs, as may be seen by comparing the number and sizes of eggs of viviparous forms. The reduction of the yolk and of the number of young has evidently gone hand in hand with the lengthening of the time the young remain in the ovary. In those viviparous species in which the yolk and the number of eggs have not at all been reduced (*Sebastes*, etc.) the young are liberated as larvæ as soon as hatched. In those viviparous species in which the young remain for a long period in the ovary, from which they derive their food (*Embiotocidae*, *Anableps*, *Zoarces*) the number of young has been reduced. In *Cymatogaster* (and *Abeona*), where the reduction of the number of young is very great, the average number being but 12, the reduction has also been carried to the yolk.

Though the size of the yolk can thus be satisfactorily explained and charged to the account of viviparity, greater difficulty is met when we attempt to determine whether other peculiar conditions observed during development, which are due to the small size of the yolk, are atavistic, or whether they are further modifications and should also be charged to viviparity. To this, however, we shall return later.

Of especial interest is the yolk nucleus,* since it is also found in *Abeona*, in which the proportions of the egg are similar to those of *Cymatogaster*.

Entodermic aggregations of protoplasm have been described by List (Z. W. Z., 1887, 595) for *Crenilabrus tinca*, which "zeigt also was die Anordnung der Keimsubstanz auf dem Dotter betrift grosse Uebereinstimmung mit dem durch Kupffer's Untersuchungen bekannt gewordenen Ei des Herings" (p. 598). I have not seen Kupffer's work, but have examined the eggs of another species (*Clupea mirabilis*), which, since the germinal matter is yellow, show the entodermic mass of protoplasm to good advantage. In the case of this species, as well as in the case of *C. tinca*, the entodermic mass is not a "selbständige Masse," but is *merely a thickening of the periblast*, which extends over the whole yolk and which disappears at the expense of the growing germ. But even in these cases this thickening is of doubtful significance, and it is still more so in *Cymatogaster* and *Abeona*, in which it forms an isolated mass sunk deep into the yolk without any apparent connection with the germ, and where it remains intact until the closing of the blastopore. It might be possible that the entodermic mass has here collected in a space formed in the yolk by the phylogenetic degeneration of an oil-globule, if the oil-spheres in teleosts occupied a fixed position. But all those that I have been able to examine can change their positions without a greater disturbance than would be created by changing a floating ball from one part of a vessel of water to another. The fact also that angles from this mass sometimes project in between the surrounding yolk-spheres argues against the supposition that it represents a degenerate oil-sphere. On the other hand, Wilson has lately shown that there is a cap of protoplasm covering the oil-globule in some pelagic eggs. But Wilson's figure (1) does not show conclusively that the protoplasmic cap is not the result of reagents. The oil-globule figured by Wilson is not of the shape of the oil-globules seen in living eggs and the space occupied by the protoplasmic cap may be due to contraction. I have seen similar spaces in other eggs filled with stainable material. Its position remains fixed at the entodermic pole of the egg till the closing of the blastopore, and is therefore an excellent landmark for orientation.

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* This has been identified with the yolk nucleus of ovarian eggs. It is not homologous with the entodermic aggregations of protoplasm mentioned in the succeeding paragraph, with which it was at first identified. For a history of the early stages of this, see Hubbard, 1894; for the later stages see paragraphs headed *yolk nucleus*, p. 440.

Segmentation.—The first segmentation plane is meridional and divides the germ into two equal blastomeres. The surface views of this stage are represented in figs. 1 and 3. The groove separating the sphere varies in depth according to the stage of division. The constriction between the yolk and germ also differs in different eggs. The nuclear figures can not be distinctly made out, and it was but once that I was able to definitely distinguish the resting nuclei (fig. 3). Sections show that the dividing plane reaches entirely through the germ to the yolk before the second division begins and that the line dividing the germ from the yolk, though irregular, is well marked (figs. 4 and 5). The division is further indicated by the fact that yolk and germ readily part. The yolk shows no signs of segmentation, and if the yolk ever does segment in teleosts it ought certainly to show some signs of it where so little resistance is to be overcome as in *Cymatogaster*. The conditions described by M. Kowalewski, 1883, for the goldfish are probably not due to the segmentation of the yolk, but to the retarded segregation of yolk from germ and the consequent indistinct boundary between the two. During this first segmentation there is still considerable protoplasm scattered through the yolk, and the lower margin of the blastoderm, though quite distinct, is not yet as well defined as in later stages. The germ, on killing with strong O. C. A. and staining with Grenacher's hæmatoxylin, is seen to be finely granular, with a few larger granules, many of them arranged along the division planes. A granular network of protoplasm extends also through the yolk. A few yolk-spheres are, on the other hand, found in the germ (4), some of them being arranged along the division plane. The yolk nucleus at this stage is stained darker than the germ, has an irregular outline, and is apparently composed of protoplasmic granules similar to those of the germ, but more compact, and of a few yolk-spheres (fig. 4, *yk. pr.*).

The second segmentation plane is also meridional and at right angles to the first. This is seen both in segmentation spindles of mounted 2-celled eggs and in the division plane itself (fig. 2).

Authors in general have been agreed that the third segmentation planes are parallel to the first in fishes. List, 1887, on the other hand, claims that the second segmentation appears almost simultaneously with the first in *Crenilabrus tinca* and is equatorial, and that the third is again meridional and at right angles to the first; while Brook, 1886, maintains that in the herring the third is the equatorial segmentation. Hoffmann, 1888, claims to have found the fourth segmentation to be horizontal in the salmon, but since Brook found the third to be horizontal or equatorial, he concludes that this is the rule, considering *Amphioxus*, Cyclostoms, and Amphibians. The fourth cleavage of Rauber, Kowalewski, Ryder, Agassiz, and Whitman, that is, the cleavage which according to them divides the germ into 16 cells, is not the fourth, but the fifth, etc. (Hoffman, 1888, p. 532). Wilson considers the third cleavage, the one parallel to the first, the homologue of the fourth in the frog.

I have seen nothing of a horizontal third cleavage in the various species of eggs I have examined, and, in the face of so much evidence to the contrary, am doubtful whether the third cleavage is equatorial in the sense used by Hoffmann, *i. e.*, horizontal. If the first equatorial segmentation is the third cleavage and horizontal, then, indeed, the large yolk accumulated at one pole is an intimate part of the *lower* cells with which it is represented to be connected and does not divide for lack of sufficient energy in the comparatively small cytoplasm overlying it. But in *Cymatogaster*, in which the yolk is much smaller than the germ, it is just as distinct from the germ as it is in large-yolked species, and much more so than is represented for some large-yolked species by other authors (Kowalewski). It shows, however, no signs of segmentation or other interest in the changes of the cytoplasm; on the contrary, it is during the early stages of segmentation as impassive as so much dough might be. While I am not prepared to believe that it is not an intimate part of the ovum, I do believe that, in those large-yolked species in which the yolk and germ are well separated before segmentation begins (pelagic eggs, for instance), the nuclear spindles guided by the forced shape of the germ may be displaced from their primitive direction. In other words, owing to the presence of a large yolk the four blastomeres have a greater lateral than vertical dimension. The effect on cleavage is what it might be expected to be. The third cleavage spindles, instead of being vertical, have been forced by the depressed condition of the germ to lie in a horizontal or slightly inclined position, and the third cleavage of the teleostean egg instead of being normal (equatorial) has become parallel to the first cleavage. A similar result has been obtained by compressing the segmenting eggs of the frog between two glass plates. By the compression the horizontal cleavage was changed into vertical cleavage.

An examination of the figure of the external features of an 8-celled egg, and the cross-section constructed from a wax model and made after a series of 13 oblique sections of an 8-celled egg, will lend force to the supposition that the third segmentation was originally equatorial. For now that the yolk has been greatly reduced, and the germ is no longer a comparatively flat particle, but has approached the spherical form again, the third segmentation is no longer vertical, but is oblique (figs. 6 and 8); that is, it has approached the original horizontal or equatorial segmentation. This third segmentation is probably not similar to the horizontal segmentation which Hoffmann claims for the salmon, and which is said to divide the germ into an upper and a lower layer. It may, however, be similar to that described by Brook in the herring, since the proportion of yolk to germ in *Clupea* approaches more to the proportions found in *Cymatogaster*. In the 8-celled stage, all of the cells, with perhaps one or two exceptions, touch the yolk, and all without exception form part of the external surface of the germ; they do not form distinct layers of four upper and four lower cells.

Of the 16-cell stage I found but one egg. It was killed, as usual, with Flemming's strong osmic chromic acetic, but stained with Gren. alcoholic borax carmine. It was examined *in toto* and a series of optical sections made, the planes passing through the resting nuclei. The cells are still but one layer deep, unless possibly one occupies the center of the group of cells (figs. 11–14).

After the 16-cell stage the blastoderm becomes two cells deep. Such striking bilateral symmetry as is seen in pelagic eggs I have not observed, and after the 16-cell stage is passed the determination of the first and second cleavage planes becomes largely conjectural. The stages between 16 and 70 cells are represented in vertical and horizontal sections in figures 16 to 23.

Up to this time the marginal cells have had boundaries quite as distinct as any other cells of the blastoderm. At the end of the seventh segmentation (fig. 44) some of the marginal cells have the lower margin ill defined and continuous with the yolk. This is never the case in more central cells. The nucleus is also slightly more refringent in these marginal than in the neighboring cells. At the end of the eighth segmentation (fig. 45) there is still a distinct dorsal wall to the periblast cell, but its nucleus is now much larger than that of the surrounding cells. At the end of the ninth segmentation the periblast consists of a few large, refringent nuclei imbedded in protoplasm, which is restricted to the immediate neighborhood of the blastoderm (figs. 47-49). At this time the outermost layer of the blastoderm has begun to creep over the yolk, so that the periblast cells are partly covered exteriorly by the rim of the blastoderm formed by the outermost cells. Dorsally the periblast cells are covered by the row of cells just within this outer projecting series. The periblast does not extend beneath the central cells of the blastoderm and the nuclei do not reach this region till later, after the nuclei are all that remains of the periblast. So much has been written concerning the fate of the periblast that a detailed account of it in *Cymatogaster*, where it has been reduced to its simplest formula, will follow (p. 437).

After the seventh segmentation and up to the time of the formation of the first protovertebræ the development of *Cymatogaster* shows little in common with other fishes, and an egg of this species found floating during this period would scarcely be recognized as belonging to a teleost. The rapidity characterizing the formation of the periblast characterizes the whole of this development and the difference of the blastoderm at the beginning and at the end of any segmentation is sometimes considerable. The age of each of these stages was determined by the number of nuclei in the blastoderm. While the method of counting nuclei is probably not as satisfactory as observing the successive segmentations in the same egg, this method is almost as exact, because the number of nuclei present must be doubled or diminished by half in order to change the serial number of the segmentation under consideration.

During the ninth segmentation the marginal series of cells of the blastoderm creep over the yolk. At the same time they become flattened (fig. 27). Near the end of the tenth segmentation about three series of cells (only one cell deep) have crept over the yolk and cover it from the blastoderm, which has scarcely changed shape, to the yolk nucleus, the margins of which have been extended to meet this layer of thin cells. The yolk at the end of the tenth segmentation is therefore entirely inclosed (fig. 29).

During the eleventh segmentation the yolk sinks into the blastoderm, or, in other words, the blastoderm spreads over the yolk; but the former expression is more apt, since the process in no way resembles the epibolic growth of the blastoderm over the yolk in other teleosts. In other fishes the inclosing of the yolk is accomplished by the growth of the gastrula margin, while in *Cymatogaster* it is accomplished before there is any sign of gastrulation. The inclosing of the yolk by the blastoderm during the eleventh segmentation corresponds rather to the spreading of the blastoderm in pelagic eggs just before the beginning of the marginal infolding. The yolk in *Cymatogaster* appears to sink into the blastoderm on account of its small size. At the end of the eleventh segmentation the cells of the blastoderm are not yet divided into two layers and the yolk nucleus is still exposed. (Figs. 32 to 34.) A noteworthy feature is that near the end of the tenth segmentation the outermost layer of the blastoderm consists of flat cells, which contrast strikingly with the remaining more rounded cells. This differentiation does not exist except at the margin before the tenth segmentation, at least it is not so evident, and it disappears some time after the diplastic gastrula has been formed. These outer cells seem to become distended with extraneous matter.

The changes are so rapid from one segmentation to another that a much larger series of eggs than I possess is necessary to illustrate all the phases. At this point it will be worth while to compare the results of the successive stages of the segmentation of *Cymatogaster* with those of some large-yolked teleost. Since Agassiz & Whitman have so ably discussed and figured the segmentation of *Ctenolabrus*, that species may be taken. Agassiz & Whitman, 1883, p. 45, state that the ninth generation of amphiasters is reached in two hours and sixteen minutes, and that the time between the eighth and ninth generations is fifteen minutes. From these data I estimate that their figure 3 contains amphiasters of the ninth generation, or more than 250 cells and less than 500; their figure 4, amphiasters of the thirteenth generation, or more than 4,000 cells. As stated above, the segmentation could not be directly observed in *Cymatogaster*, and in order to determine the serial number of my segmentation I had recourse to counting the nuclei, a method more laborious and inexact with each generation. Since, however, the number of the segmentation, as already stated, can not be missed unless the number of nuclei present is actually doubled or diminished by half, except at the beginning or end of a segmentation, the result thus obtained is sufficiently exact for purposes of comparison.

If we compare Agassiz & Whitman's fig. 3 (24*a*), containing amphiasters of the ninth segmentation, with fig. 24, at the beginning of the ninth segmentation, and their fig. 4 (30*a*) during the thirteenth segmentation, with figs. 41 and 42 during the twelfth segmentation, the contrast will be seen to be very great, and the work accomplished by *Cymatogaster*, between the ninth and the thirteenth segmentation, comparatively enormous. The actual time consumed in reaching these stages (three hours and sixteen minutes in *Ctenolabrus*) is in all probability different, but that does not concern us since the time of successive generations of amphiasters differs greatly in oviparous fishes in which the generations are more alike. *Cymatogaster* accomplishes in twelve generations of nuclei what is not accomplished by *Ctenolabrus* till much later. To anticipate somewhat, the stage of *Cymatogaster* just before the closing of the blastopore does not correspond to the same stage in *Ctenolabrus*, but rather to the beginning of the epibolic growth of the blastoderm. Just before the marginal infolding of the blastoderm of oviparous fishes it spreads over the yolk. This spreading probably corresponds to the sinking of the yolk into the blastoderm in *Cymatogaster*. By the time *Cymatogaster* reaches a stage homologous to that reached by *Ctenolabrus* at the closing of the blastopore, *Cymatogaster* is hatched.

The hastening in the inclosing of the yolk on account of its small size in *Cymatogaster* and the rapidity of the spreading of the blastoderm at the time of the infolding of its edge in most oviparous fishes result in the diplastic gastrula in *Cymatogaster* and the familiar condition in other fishes. The lack of a two-layered gastrula in fishes seems to be due to the rapid spreading of the epiblastic portion of the blastoderm. A large vitellus permits this spreading to take place more rapidly than the margin grows inward, so that the inner anterior and posterior margins of the embryonic ring do not ordinarily meet. An interesting egg bearing on this subject is that of *Stolephorus*, in which the blastoderm is placed at the end of an ovate egg. The lateral spreading of the blastoderm is here almost impossible, and at the beginning of gastrulation the tip of the embryonic shield is separated from the inner margin of the anterior part of the embryonic ring by but a very narrow space, through which are scattered cells; in other words, there is a very close approach to a diplastic gastrula. It is not at all improbable that in this genus eggs may sometimes occur in which the lower layer is quite continuous, and that a two-layered gastrula is formed. This condition, however, lasts but a very short time. With the epibolic growth the lower layer becomes more and more incomplete. The two-layered condition of *Cymatogaster* seems to be homologous to this early two-layered condition of *Stolephorus*.

Gastrulation.—On account of the difficulty of orientation of the stages during gastrulation, and because the contents of the zona soon fill the entire space within it, and some structures are invariably injured, owing to the necessity of cutting the zona, the process of gastrulation has not become very lucid. It will be best, therefore, to describe in detail the few favorable series of sections.

To repeat the description of the stage during the eleventh segmentation or just before the beginning of gastrulation: An egg, near the end of the eleventh segmentation (containing about 1,700 cells) was cut into twenty sections, of which, sections 3 to 15 cut through the yolk. The sections run somewhat obliquely to a meridian plane, as is indicated in the diagram, fig. 31. A section (the ninth) through near the middle of the yolk (the sixth section cutting through the yolk) is represented in fig. 33. As will be seen by the figure and by the diagram, the yolk has sunk into the blastoderm. At the ectodermic pole the blastoderm is about five cells deep. It becomes shallower towards the entodermic pole and gives out altogether at the yolk nucleus which has spread to some extent over the yolk. The yolk is, therefore, entirely inclosed, and the margins of the blastoderm are separated only by the yolk nucleus. There is no indication of a division into entoderm and ectoderm; in other words, *gastrulation has not yet begun.* There are present about 14 periblast nuclei. The breathing chamber has not been greatly reduced. The height of the egg is ·054 mm., the width ·064 mm., the diameter of the zona ·073 mm.

The next stage satisfactorily made out is of several eggs during the twelfth segmentation. There are, however, two stages of development, which, according to the estimate of cells, belong to this segmentation. Although the two stages differ considerably, it is difficult to state at a glance which is the older. In the one case (fig. 38) the blastopore is still open, and the yolk nucleus forms a plug which fills it. The ectoderm and entoderm are well separated, while the cells have become nearly evenly distributed over the yolk. In the other (fig. 35) the shape is much more like that of the eleventh segmentation; the ectoderm and entoderm are scarcely separate and the cells are still heaped up at the ectodermic part of the yolk, but the blastopore is much smaller.

Thus, while the shape and relation of ectoderm to entoderm indicate the latter (fig. 35) to be less advanced, the large blastopore points to the former (fig. 38) as the earlier stage. Everything considered, it is evident that fig. 35 represents the younger stage. The two stages are very close together and also near fig. 41. The ovary from which the egg represented in fig. 35 was taken contained several different stages, and in fact one egg in an *earlier* stage than the one represented in fig. 33 and another in about the stage represented by fig. 38.

In fig. 35 the outermost layer of cells is quite distinct from the others. The cells are mostly flat, quite small and stain (with Grenacher's alcoholic borax carmine) slightly deeper than the other cells. *The cells of this layer are the only ones which cover the yolk nucleus*, leaving but a minute naked portion, the blastopore (fig. 36). They are more distinct in some sections than in others, but are everywhere quite evident. The axes of the remainder of the cells are more alike. These cells do not extend much, if any, beyond the margins of the yolk. The plane of the sections of this egg is meridian, probably but slightly inclined to the sagittal. The lower layer of cells is well separated from the upper layer. At the median portion the blastoderm is still many (6 to 7) cells deep and the separation between ectoderm and entoderm is not yet so distinct. The cells, however, which will form the entoderm are smaller than those overlying them.

Figure 38 represents a section of a gastrula in all probability cut in a sagittal plane. The yolk in this section is pear-shaped, the narrow end being composed of the yolk nucleus. The latter is composed of a more granular refringent portion and a more uniform part resembling the protoplasm of the cells. The cells are grouped into a one- to three-cell-deep ectoderm and a one-cell-deep entoderm which becomes two and then several cells thick towards the dorsal edge of the blastopore. The outer layer of the ectoderm is flattened in places; the inner cells are rather loosely connected. On the upper part the entoderm cells lie close against the yolk and form a continuous series. The division in this case between the entoderm and ectoderm is well marked by a space which was probably produced by the reagents (osmic, chromic, and acetic strong mixture). Near the blastopore, in what would correspond to the embryonic ring in other teleosts, the two layers merge more or less.

Figs. 41 and 42 represent two parallel sections from another egg of the same ovary, cut transversely or in a vertical plane at right angles to the sagittal. All these eggs are in the same stage of development. In the eggs represented in fig. 40 the yolk nucleus consists of an irregularly biconvex portion, whose peripheral part stains deeper, and which contains some bodies which stain less and a more uniform part forming the matrix of the former. The cells, as in fig. 38, are divided into an ectodermic layer and an entodermic layer. Some of the outer layer of cells of the ectoderm have become greatly distended, probably by absorption of the intra-ovarian fluid, which fills the breathing chamber and stains as these distended cells do. The line separating the entoderm from the ectoderm is quite distinct, but along the median portion, or at the axis of the embryo, the entoderm is several cells thick. The same is indicated in the horizontal sections. The shape of the yolk is different in the three eggs, but they agree in all essential respects, and figs. 38 and 41 must represent a normal stage in the development of *Cymatogaster*. The question now arises as to how this gastrula has been formed from the condition represented in fig. 33.

The fact that there is a marginal ingrowth of cells to form the lower layers in teleosts generally has been observed by so many authors, and is so evident from the fact that the space between the inner margins of the embryonic ring is reduced in some cases, notably *Stolephorus*, that it is beyond dispute. Does the method of the formation of the gastrula in *Cymatogaster* form an exception to the rule? It must be borne in mind that the changes undergone between the stages represented by figs. 33, 35, and 38, all take place during the time occupied by the latter half of the eleventh segmentation and the first half of the twelfth. During this time, if the usual course is followed, all but the outermost layer of the blastoderm must be inflected at the margin of the blastopore and must *meet* somewhere below the ectoderm; and, by a further comparison of figs. 33 and 41, it becomes evident that the bulk of the cells of the median portion of the blastoderm of fig. 33 must migrate toward the margin before the infolding can produce the conditions seen in fig. 38. If the formation of the gastrula of *Cymatogaster* follows the usual method, fig. 38 is derived from fig. 33, after the manner just described, granting, of course, that both figs. 33 and 38 represent *normal* conditions. Considering, however, the great rapidity with which this process takes place, and examining fig. 41 in connection with fig. 38, it seems probable that the infolding process may be slurred over, and the lower layer, or primitive entoderm, be formed by a process of delamination.*

In this connection the stage represented in fig. 35 becomes interesting. If this stage be compared with the one represented in fig. 33 the great probability that the condition represented in fig. 35 is derived by simple delamination from fig. 33 becomes quite evident.

The shape of fig. 33 is retained by fig. 35, which can readily be derived from the former by further division and a slight progress of the epidermal layer over the yolk nucleus. But in fig. 35 the entoderm is already well separated from the ectoderm near the margin, and the division, while not so distinct at the median portion, is evident both as a line and in the size of the cells. While, then, figs. 41 and 38 make it seem possible that the lower layer is formed by delamination, fig. 35 makes it certain that it is so formed.

Now, as to the changes in fig. 35 necessary to produce fig. 41. We see in the fig. 35 the beginning of the constriction of the yolk at the margin of the entoderm which gives the yolk in fig. 41 its peculiar shape. The margin of entoderm has advanced toward the entodermic pole at a uniform rate on all sides while the epidermal layer of cells has been apparently passive. In fact, the blastopore in fig. 41 is larger than in figs. 35 and 36, but the margins in fig. 41 do not correspond to the margin of the epidermal blastopore of figs. 35 and 36, but to the shaded portion of fig. 36. The epidermal layer in fig. 41 is not everywhere evident, and where it is most conspicuous the cells are distended and feebly stained. This is probably due to intracellular digestion, as was mentioned above, but it may be due to the degeneration of this layer of cells. Certain it is that in this stage the epidermal layer is not distinguishable near the blastopore, where it is so evident in stage 35.

In the stages immediately succeeding those represented in fig. 41 the yolk nucleus disappears and the yolk assumes a more or less spherical outline. Its fate will be discussed later. With its disappearance, the "fixed point" so useful in orientation is lost.

From the fact that the entoderm is formed by delamination and the anterior end of the embryo lies at one margin of the blastopore and the posterior end at the other (?), the fundamental difference between the gastrula of *Cymatogaster* and that of teleosts in general may be gathered. The embryo of teleosts in general is formed by the concrescence of the embryonic ring from before backward, and the embryo rarely encircles more than half of the yolk. (*Clupea*, a genus with a small yolk, forms a notable exception.)

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* Wilson, p. 220, says: "It is, to be sure, very doubtful whether there is any vertebrate in which the primitive hypoblast is really delaminated from the upper layer."

The methods of concrescence employed by teleosts in general are obscured in *Cymatogaster* beyond recognition. In fact they are slurred over entirely, for just at the time when in other teleosts the infolding process and the formation of the embryo begin, the blastopore is in the act of closing in *Cymatogaster*. Though the gastrulas appear to have nothing in common, the conditions in *Cymatogaster* after the embryo has been formed can readily be derived from large-yolked teleost eggs by simply imagining the yolk to be reduced. Ryder has shown that the arc formed by the larva varies inversely as the yolk. For example, in large-yolked species, as the trout, the embryo forms an arc of but 90 degrees. From this, as an extreme, there is a complete series of intermediate forms till we reach *Clupea*, in which the embryo, just before the tail buds out, encircles almost the entire yolk. In *Cymatogaster* the head and tail overlap just before the tail begins to grow out, or shortly after the time of hatching. Bearing these facts in mind, the incongruous gastrula of *Cymatogaster* becomes more intelligible.

With the reduction of the yolk, unless this is proportionate to the reduction of the germ, which it is not, the embryo must necessarily form a greater and greater arc, until it finally forms a complete circle. From this it is evident that, although the methods employed by *Cymatogaster* have become greatly modified, the result is perfectly homologous with the result of gastrulation of other fishes. Ziegler[*] (1882) homologizes the yolk and periblast of teleosts with the yolk cells of the amphibia. Wilson (1891) indorses this view and explains the steps by which the amphibian egg was changed into the teleostean egg in the following words:

> The alimentary canal is formed from the roof of the archenteron exclusively. How this was effected is easy to see. The increase in the size of the mass of yolk cells (of *Amphibia*) brought it about that the dorsal parts of the embryo were early folded off—some time before the alimentary canal was completed ventrally. The division of labor, already far advanced between the dorsal and ventral hypoblast of the gastrula, next took the final step; the dorsal hypoblast assumed the entire function of forming the gut, while the ventral hypoblast became transformed into pure food material. The yolk is consequently to be looked on as an organ of the gastrula, which has lost its original function, but which, in doing so, became adapted to another function to which it owes its large size.

The major premise in this argument is that the yolk in teleosts is much larger than in *Amphibia*. But is it larger? It is larger in certain forms—*Salmo*, for instance.[†] This accounts for Ziegler's view, since he studied a large-yolked form. It is just as certainly smaller in certain other eggs, *Abeona*, *Cymatogaster*, and *Clupea*, and it seems to me as proper to take the extremes in one direction for comparison as those in another. If the egg of *Cymatogaster*, for instance, is compared with the amphibian egg, we can not with Wilson say that the teleostean conditions are due to "the *increase* in the size of the yolk cells of amphibia," for there is a *decrease* in the bulk of the yolk, and therefore in the yolk cells, if the yolk is formed by the union of such cells. Of course it may be argued that *Cymatogaster* is not a fair representative of teleostean ova, because a reduction of the yolk has been brought about by viviparity. If, however, the teleostean egg has been *immediately* derived from the amphibian egg, through increase of yolk, we may properly suppose that with the reduction of this same yolk the egg will show some atavistic features in the partial or occasional segmentation of the reduced yolk. But the tenacity with which the egg

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[*] For this statement of Ziegler's views I am indebted to Wilson (1891), pp. 264, 265.

[†] It is very large in *Tachysurus*.

of *Cymatogaster*, which contains much less yolk than the amphibian egg, persists in segmenting only the germ and not the yolk tends to show that the teleostean egg is not immediately derived from an egg similar to the amphibian, as Wilson states, but that the teleostean condition is deep-rooted and of very long standing.

Balfour's (1885, p. 68) view (which Wilson does not mention) is thoroughly in harmony with the conditions found in *Cymatogaster*, as well as with those of *Salmo*, and I see no valid reason for changing it. His view very tersely expressed is:

> The peculiarities of the development of the teleostean ovum can best be understood by regarding it as an elasmobranch ovum, very much reduced in size.

Agassiz & Whitman (1884) indorse this view, and Miss Clapp's discovery of the closing of the blastapore behind the embyro in *Batrachus*, a large-yolked teleost, brings the final proof of this view. It is probable that conditions will be found in *Tachysurus* which are similar to those in *Batrachus*.

There can be no question but that teleostean ova, as all other telolecithal ova, have been derived from *alecithal* ova, such as those of *Branchiostoma*. The question at issue is whether the conditions found in the fishes have been derived immediately from some egg resembling the amphibian egg, or whether from some egg like that of elasmobranchs. The nonsegmentation of the yolk in small-yolked teleosts, the discogastrula of *Cymatogaster*, and the close approach to the discogastrula in the oval egg, in which the germ lies at the narrow end of the yolk, as in *Stolephorus*, all point to the fact that the teleostean egg was not directly derived from an amphibian-like egg.

Ryder's (1887, p. 493) modification of Hæckel's theory seems to me much nearer the truth. Both suppose the yolk to fill the archenteron of the primitive *Branchiostoma* gastrula—very nearly the condition found in *Cymatogaster*. Wilson admits "that this theory offers an explanation of the early teleost gastrula, but it becomes utterly unsatisfactory as soon as what Balfour has called 'the asymmetry of the vertebrate gastrula' begins to appear in the fish embryo. For the teleost gastrula of Ryder and Henneguy is a symmetrical gastrula, and they are consequently unable to explain why it is that (continued) *invagination takes place at one pole of the blastoderm, while the other pole grows epibolically round the yolk.*" The major premise of this argument lies in the words I have italicized. Wilson takes it for granted that this premise is correct, although he has not proved that this is really the condition in *Serranus*—the form he studied (see page 436). Certainly it is not the case in *Cymatogaster*, in which the gastrula is a symmetrical gastrula, and the blastopore closes at exactly the entodermic pole of the egg. It is not the case in two species of pelagic eggs (*Stolephorus*), in which I have examined the gastrulation, for these also have symmetrical gastrulas, and the blastopore closes at the entodermic pole of the egg. The preceding italics, describe exactly what does not take place in *Cymatogaster* and in *Stolephorus*, in which the anterior and the posterior margins of the blastoderm grow equally over the yolk. In *Stolephorus*, as I have stated elsewhere (1891), the germ lies over the narrow end of a very elongate yolk. To all intents and purposes we have, therefore, a small-yolked teleost ovum, and when gastrulation takes place the marginal ingrowth exceeds (on account of the narrow yolk) the restricted lateral spreading of the blastoderm. The result is that the tip of the embryonic shield comes in close proximity to, if not in contact with, the inner margin of the anterior portion of the blastodermic ring—an almost complete diplastic gastrula is formed. Nothing could more forcibly illustrate the manner in which the discontinuity of the lower layer of cells was formed by the addition of yolk to the *Branchiostoma* gastrula and the result of subsequent reductions, than the early gastrula of *Stolephorus* and the condition in *Cymatogaster*. A comparison of the gastrula of *Cymatogaster* with that of *Branchiostoma* and of the frog is interesting. The gastrula of *Cymatogaster*, exclusive of the yolk, is remarkably like the gastrula of *Branchiostoma* as figured by Kowalewsky. In fact the peculiar conditions in *Cymatogaster* are just what might be expected if the ventral hypoblast cells of *Branchiostoma* should in some way become eliminated. This elimination has probably been brought about by the fusion of these cells, through their enormous surcharge with yolk and by the subsequent reduction of this yolk without a restoration of its original cellular constitution. In those cases (elasmobranchs and teleosts in general) in which the yolk is functional it occupies the space originally occupied by the ventral hypoblast cells; *i. e.*, the region between the tip of the head and the anterior or ventral margin of the embryonic rim.

Detailed homologies between parts of the *Branchiostoma* and parts of the *Cymatogaster* gastrula can not with certainty be pointed out till the first stages in the formation of the embryo of *Cymatogaster* have been observed. Both the gastrulas are formed by a layer of epiblast and a layer of hypoblast, and the region of the dorsal lip of the blastopore of *Cymatogaster* is in all probability homologous with the dorsal lip of the blastopore of *Branchiostoma*. The ventral portion of the former gastrula has, however, been so reduced that the embryonic axis extends over more than half the circumference of the gastrula. While the gastrula of *Cymatogaster* is thus seen to approach that of *Branchiostoma*, it is by no means primitive, but is highly specialized by the reduction of the yolk, or, in other words, by viviparity. This is to be expected, for, as Balfour long ago expressed it (II, 342):

> If the descendants of a form with a large amount of food yolk in its ova were to produce ova with but little food yolk, the type of formation of the germinal layers which would thereby result would be by no means the same as that of the ancestors of the forms with much food yolk, but would probably be something very different, as in the case of Mammalia.

Cymatogaster appears to me to stand at the very end of the series of teleostean eggs which have been derived from large-yolked elasmobranch eggs.

A glance at the gastrulas of *Cymatogaster* (fig. 41) and of the frog (Balfour, fig. 71, B) shows an interesting similarity. The yolk in the frog bears the same relation to the blastopore that it does in *Cymatogaster*, the yolk plug of the frog being represented by the yolk nucleus in *Cymatogaster*. But here again the embryo occupies less than half the circumference of the entire egg. The conditions in this case would be nearer those of *Cymatogaster* were there less yolk. There is, however, a very serious objection to deriving the teleost gastrula directly from the amphibian gastrula, for by such a supposition the periblast of the teleost must arise *de novo* from the yolk cells of the amphibian and stand in no relation phylogenetically to the yolk nuclei of the elasmobranch, a supposition very absurd on its face.

In Wilson's opinion one of the prime objections to deriving the teleost gastrula from the *Branchiostoma* is that "the theory leads us nowhere; it does not admit of any *exact* comparison between the teleostean embryo and those of other vertebrates." It will be well to bear this statement in mind in further considering the homology between the amphibian and the teleostean egg.

According to Wilson's view the whole course of the fish development becomes easy to understand if we admit of the homologies between the gastrulas of the amphibian and the fish pointed out by Ziegler. The homologies are as follows:

Fish.	*Amphibian.*
Yolk+periblast	=Yolk cells
Invagination at posterior pole of the fish blastoderm.	= Invagination around the dorsal lip of the amphibian blastopore =Chorda-entoblast.

The gastrula cavity of the fish lies between the invaginated layer and the periblast.

> The growth of the anterior pole of the blastoderm round the yolk represents the growth of the the small cells round the yolk cells in amphibian gastrulation.

This takes it for granted, again, that the posterior margin of the fish blastoderm is stationary, which it is not, and it has recently been shown by Morgan that the "small cells" of amphibian eggs do not spread over the yolk cells, but are split off from them. The "exact" comparison can no more be instituted here than between *Branchiostoma* and the teleost. He nowhere explains how the periblast has arisen from the yolk cells. The condition in *Cymatogaster* shows that the periblast (composed of but 12 nuclei) is a waning structure and is in direct proportion to the size of the yolk, a condition which very strongly presupposes a larger yolk and a more active periblast, as is found in other teleosts and in the elasmobranchs.

Wilson's discussions of concrescence do not directly concern us, but the chief objections to his views should be stated. His theory and observations need to be stated to enable us to form a fair judgment. He says, p. 260:

> In the growth of the blastoderm round the yolk, the head end of the embryo does not remain a fixed point. * * On the contrary, the *tail end of the embryo* * * *remains a comparatively* fixed point, as Oellacher first showed, while the anterior pole of the blastoderm travels rapidly round the yolk.

I have already shown that this is certainly not the case in some fishes.

> The point where the blastopore closes is thus but a short distance from the original position occupied by the posterior pole of the blastoderm. Owing to the constant position of the single oil-globule, these facts can easily be made out.

Compare figs. "35," "36," and "38." In other words, these statements hinge on the fixity of the oil-globule. Now, I have certainly seen the oil-globule in a number of eggs shift its position if the egg was forced to lie in a position in which the vertical line passing through the oil-globule did not also pass through the center of gravity of the egg; that is, if the globule did not occupy the highest point in the egg. Bearing this in mind, and also the fact that the protoplasm is heavier than the yolk, as is seen in the position of the germ in pelagic eggs *without oil-globules* and the position of the newly-hatched larvæ of such eggs, the conditions figured by Wilson, 33, 36, and 38, can be explained as being due to purely mechanical causes, by supposing that the egg, on account of the change in position of the mass of protoplasm during the formation of the embryo, rotates 90° and that the oil-sphere, in order to remain at the highest point of the egg, gradually shifts its position 90°. To make this clear I reproduce Wilson's figures and add diagrams. These figures represent the egg in a vertical median section through the axis of the embryo; the germinal ring is also indicated.

Since the center of gravity of the yolk lies approximately at the center of the egg, and the oil-sphere occupies the highest position, while the germ occupies the lowest, the center of gravity in fig. "35" lies somewhere in or very near the line joining the center of the oil-sphere, the center of the egg, and the center of the blastoderm.

By the equal growth of the blastoderm over the yolk and the formation of the embryo along its posterior part (*B*) the center of gravity of the blastoderm is changed from a point in a line joining C and a (fig. *A*) to a point in the line joining $C'b$ (fig. *B*). This change of the center of gravity rotates the egg till the line cb coincides with the vertical. The oil-globule in the meanwhile shifts its position so that its center lies in the extended line joining b and C'. The globule must move if its position is not absolutely fixed, and it certainly is movable in some pelagic eggs, and probably is in *Serranus atrarius*=*Centropristis striatus*. The rotation of the egg is as gradual as the growth of the embryo, and the change of position of the oil-sphere can not be observed on that account during natural development. The conditions of diagram *C* are produced by the continuation of the same process. Since the center of gravity of the embryo will naturally be somewhere near its middle, the head and tail will be kept approximately equidistant from the oil-globule. The center of gravity travels with growth from the tip of the head in *A* to the middle of the body in *C*, and since the embryo encircles about half the yolk the change amounts to about 90°. The center of gravity of the yolk being fixed, the egg, which is free to respond to the slightest change, rotates an amount equal to the change of position of the center of gravity of the germ. This does not seem to have occurred to Wilson, else this explanation would not be necessary, especially since Ryder gave a similar explanation in 1886, p. 10.

The above supposition, which is entirely warranted by the conditions figured for the bass and by the conditions observed in other eggs, explains why the anterior and posterior margins of the blastoderm progressing evenly, the blastopore does not close over the oil-globule. It does close over the position originally occupied by the globule or very near it. On this supposition the embryo is formed by the continuous concrescence of the embryonic rim, the head being the first part formed and remaining fixed. It may be worth stating that, at the beginning of development by the more rapid ingrowth of cells at the posterior margin of the blastoderm, the embryo, so to speak, is pushed towards the anterior rim of the blastoderm, as in *A*. But this process ceases when the more active epibolic growth begins.

Now let us examine the explanation Wilson gives for this simple matter, using the same figures and diagrams, bearing in mind that he considers the oil-globule a fixed point:

> On comparing figs. 35 and 36, it is seen that while the posterior pole of the blastoderm remains comparatively fixed, the head end (*a*) of the embryo follows, though at a much slower rate, the anterior pole of the blastoderm in its growth round the yolk.

In other words, if we compare the figures the backward growth of the posterior margin of the blastoderm plus the anterior growth of the embryo represented by xa' equals the advance of the anterior margin of the blastoderm represented by $y'y$.

> The comparison of the two figures inevitably leads to the conclusion that the increase in length which the embryo undergoes in passing from one stage to another is due to intussusception and not to concrescence. Extending the comparison to the later stage (fig. 38, just before the blastopore closes), it is seen that the increase in length which the embryo undergoes between the stages represented by figs. 36 and 38 is brought about in a different way from that between figs. 35 and 36 (!). This is shown by the following examination: At the beginning of the older period (fig. 36) the head and tail end of the embryo are approximately equidistant from the oil-globule, and at the end of the period (fig. 38) the case is the same. The head end of the embryo has, therefore, continued to grow round the yolk, as in the period figs. 35 to 36, and the body has also lengthened at the opposite end in an opposite direction. The increase in length at the tail end of the embryo deserves especial attention. The great increase in length which the body undergoes by the growth round the yolk of the

head end of the embryo (figs. 35 to 36, and also figs. 36 to 38) can only be explained as ordinary growth by intussusception. If this is so, it is perfectly fair to assume, until the contrary is proved, that the comparatively small increase in length which the body receives at the tail end is due to the same sort of growth.

I think myself that if the head end grows by intussusception the tail end does also. But if the greater amount of growth takes place at the head end, does that not imply that this is the last part to be formed? The oil-globule being a fixed point, the embryo has added to its length between figs. "35" and "38" at the head end the distance between *n* and *a''*, *or half its entire length*, while only one-sixth of its length was added to the posterior end between figs. "35" and "38" (the distance between *x* and *x'*). The first part formed by the embryo must necessarily be, according to this view, the region (nearly) between *x* and *n* in fig. 38, which corresponds to *xa* in fig. 35. To put this more precisely, the fifth and sixth sixths of the embryo are the first parts formed, and to this rump is added the whole of the head and anterior part of the trunk and the neurenteric region. All this comes from the necessity of considering the posterior margin of the blastoderm a comparatively fixed point to make out the homology with the amphibian egg. It is very probable that the anterior margin of the blastoderm does grow over the yolk more rapidly than the posterior *in those eggs in which the embryo* encircles less than half the circumference—*Tachysurus*, *Salmo*, and *Batrachus*, for instance—and it is just as probable that the *posterior margin* grows over the yolk more rapidly than the anterior *in those eggs in which the embryo encircles more* than half the circumference of the yolk. There are intermediate eggs, *Stolephorus*, *Serranus*,* and most other pelagic eggs, in which the anterior and posterior margins of the blastoderm grow over the yolk at an even pace. Since writing the above I find that these supposed conditions were actually observed, and Wilson was consequently refuted by Ryder as long ago as 1882, p. 114. Wilson does not mention another possibility than his own observations.†

Explanations of figures and diagrams.—Figs. "35," "36," and "38" are copies of Wilson's figures bearing the same numbers. The position the blastoderm originally occupied is shown by the line *x-y*, and the relation of the embryo to the blastoderm and the relative growth of the anterior and posterior margins of the embryonic ring can be seen at a glance. Between figs. "35" and "36" the anterior margin of the embryonic ring has traveled from *y* to *y'*, and the tip of the head from *n* to *a'*. Between figs. "36" and "38" the head end of the embryo travels to *a''*, while the posterior end travels to *x''*. It should be noticed that the tip of the head in "36" and "38" retains approximately the same position in relation to the center of the blastopore that it does at the beginning of its formation in figure 35. During all this time the oil-globule has remained stationary. This is Wilson's explanation of these figures.

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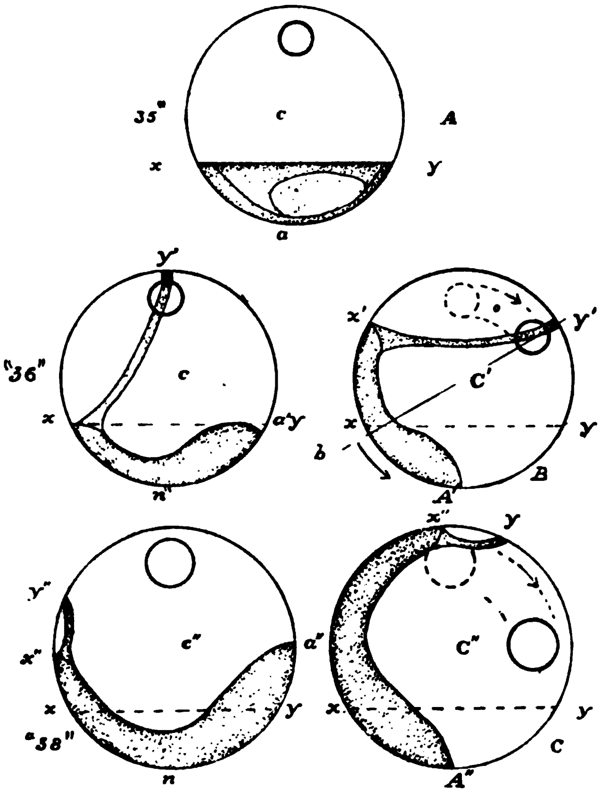
* In *Serranus atrarius*, as figured by Wilson, the embryo encircles slightly more than half a circumference and the posterior margin may travel very slightly faster than the anterior.

† In this connection, the following from the American Naturalist, January, 1894, is of interest. The statement occurs in an abstract of Morgan's experimental studies on teleost eggs: "It can also be shown by marking the membrane with carmine that the head is a fixed point, the elongation of the body being posterior to this. The experiment bears out my observation on the oval pelagic eggs of *Stolephorus*, referred to above and figured and described in the Proceedings U. S. Nat. Mus. for 1892 (p. 139, pl. XII).

A, *B*, and *C* are precisely the same figures except that the vertical axes of *B* and *C* correspond to the vertical axis of *A*. They are placed in this position to make clear the necessity of rotation of the egg and the change of position of the oil sphere, if, as I hold, the anterior and posterior margins travel equally over the yolk. The original position of the blastoderm in *B* and *C* is represented by *x y*. (This does in no way agree with *x y* of "36" and "38"). In the development growth takes place at the posterior end of the embryo while the tip of the head remains fixed. Since growth takes place in this manner the embryo, if the original axis is maintained, comes to have a lateral position, and the blastopore will close at the entodemic pole of the egg. This explains why the tip of the head is equidistant from the anterior and from the posterior margins of the blastoderm. But owing to the fact that the germ is heavier than the yolk the egg rotates in the direction of the arrow at *x*, and the oil-globule at the same time travels from its original position, indicated by the dotted line, in the direction of the arrow. This explains why the oil-globule remains equidistant between the head and tail of the embryo.



Periblast.—So many accounts have appeared during the past eight years describing the origin of the periblast, that it is not necessary to open the main question again, especially since the later accounts agree in the chief points. The first clear account of the origin of the free nuclei was given by Agassiz & Whitman, 1884. Since then several observers have verified their results. Concerning the function and ultimate fate of the periblast nuclei there is still some difference of opinion. Henneguy (1889, pp. 46–52) has given an excellent résumé of these opinions.

Kupffer, Van Beneden, Henneguy *et al.* believe that cells are added to the germ from the periblast without stating that the cells will play any definite rôle. Klein and Van Bambeke believe that the entoderm is derived from the periblast. Hoffmann (1883) formerly believed that the periblast had nothing to do with the formation of the blastoderm; but later (1888) he inclined to the view that the entoderm with all its derivatives comes from the periblast.

Kowalewski (1886) states that the free nuclei increase in size, and finally disintegrate. The function (p. 455) of the periblast he considers "eine ernährende und seine Bedeutung die eines provisorischen Organes das nach der Beendigung seiner Function zu Grunde gehet." Hoffmann (1883) and Ziegler are of similar opinion. In the goldfish Kowalewski found the periblast to arise below the whole of the blastoderm. In *Polyacanthus viridiamatus* they arise only at the margin.

Wenckebach (1886) in studying *Belone* found that the periblast nuclei arise as early as the 64-cell stage, and that they increase at the margin of the blastoderm both by fission and by the disappearance of the cell walls of two or three series of cells. The same conditions he finds in *Perca fluviatilis.*

In another egg (the largest pelagic egg, 4 mm., a *Stolephorus*) a number of cells of the lower side of the blastoderm swell, become loose, assume an irregular form, and fall to the bottom of the segmentation cavity and unite with the periblast. The periblast in this case arises at the base as well as the margin of the blastoderm. A similar condition was also found by Oellacher, (Z. W. Z. XXIII, 12) in the brook trout. Wenckebach further found that the periblast nuclei undergo a slow degeneration (p. 231) and have no part in the formation of the embryo. They become enlarged and in colored preparations show an irregular, large-meshed structure which is evidently due to the formation of vacuoles in the nucleus. They no longer divide. The ultimate fate of the periblast nuclei is degeneration and absorption. He found the residue after yolk absorption rich in protoplasm in which the nuclei were heaped. They become irregular in outline, structureless, and finally merge into one mass before final absorption. He is not certain as to their function.

Hoffmann (1888) states that the third segmentation in the salmon is horizontal and separates the lower four periblast cells from the upper. At this stage the lower cells have distinct lateral boundaries. As soon, however, as the first merocytes (cells derived from the periblast) are formed the margins of the periblast cells are lost. Through equatorial cleavage new merocytes are continually produced by the free nuclei, while through meridional cleavage the number of free nuclei which remain in the plasma of the yolk is increased and they soon extend over the yolk beyond the margin of the blastoderm. As soon as a large number of merocytes appear the periblast nuclei are transformed into bodies which may be larger than the overlying cells.

McIntosh and Prince (1890) also give a long discussion of the various theories of the origin and meaning of the periblast, without, however, touching the vital points. Wilson (1891) finds that the periblast nuclei become greatly vacuolated and that their outlines become irregular. The physiological use of the periblast he does not know. He supposes that the periblast is finally absorbed by the liver.

The periblast seems to me to have been studied and discussed a great deal more than its importance warrants and I shall confine myself to describing the actual conditions found in *Cymatogaster*. I may only say that Agassiz and Whitman's conclusions as to the origin of this layer are borne out by this fish, and the accounts, when these are based on actual observations differing from theirs, are probably all due to a modification of the process in different fish. The present function of the periblast nuclei is the appropriation of the yolk for the blastoderm—a view well borne out by the reduction of these nuclei with the reduction of the yolk to a mere vestige in *Cymatogaster*.

At the closing of the blastopore the periblast consists of about 12 (10 to 18) large irregular nuclei embedded in the cortical layer of the yolk. There is no layer of protoplasm connected with these nuclei. They are usually grouped in pairs and sometimes are almost entirely confined to that portion of the yolk which originally was not covered by the blastoderm. Its origin is similar to that in *Ctenolabrus* as described by Agassiz and Whitman. It becomes, however, an independent layer much earlier than in *Ctenolabrus* where the nuclei do not become independent till close of segmentation. Not nearly all the marginal cells of the blastoderm take part in its formation. "At the end of the seventh segmentation (fig. 44) some of the marginal cells have the lower margin ill-defined and continuous with the yolk. This is never the case in more central cells. The nucleus is also slightly more refringent than in the neighboring cells. At the end of the eighth segmentation (fig. 45) there is still a distinct dorsal wall to the periblast cell, but its nucleus is now much larger than that of the surrounding cells." In shape it does not differ greatly from the surrounding cells. It is thus seen that before the nuclei are well separated from the blastoderm they begin the change to the characteristic of later stages of other teleosts. "At the end of the ninth segmentation (figs. 46 to 51) the periblast is an independent structure consisting of a few large, refringent nuclei embedded in protoplasm which is restricted to the immediate neighborhood of the marginal cells of the blastoderm." Exteriorly these cells are partly covered by the epidermal cells, dorsally they are covered by the cells just within the epidermal cell. The plasmodium of the periblast does not extend beneath the central cells of the blastoderm and the nuclei do not reach this region till much later, if at all. There is never a continuous layer of protoplasm at the base of the blastoderm. In fig. 51, of an egg sectioned horizontally, there are 10 periblast nuclei, one of them dividing and all of them lying just below the marginal cells of the blastoderm. This egg is near the end of the ninth segmentation, containing about 450 nuclei. Up to this stage the nuclei retain their spherical outline, but from this on they increase in volume and lose their regular contours and the surrounding protoplasm is greatly reduced or disappears entirely (figs. 38, 40, 41, etc.).

The fact that the nuclei are very frequently in pairs would indicate that they undergo division, and indeed some sections show this to be the case. It is, however, doubtful if more than two generations of nuclei are produced in this manner.

At the end of cleavage (fig. 29) there are several series of flat cells covering the greater part of the yolk. Beneath them the periblast nuclei lie. In *Ctenolabrus*, at the end of cleavage, the periblast forms a wreath of flattened cells.

The exact number of nuclei arising directly by a change of the cells containing them I was unable to determine, but their ultimate number rarely, if ever, reaches 20. Reduced to such simple conditions and differing as the nuclei do from the nuclei of the blastoderm even before they are entirely free, I can state with the greatest confidence that these nuclei have no share whatever in forming the embryo or in giving rise to even a single cell of the embryo. The number of periblast nuclei probably remains the same from the closing of the blastopore to the final disappearance of the yolk. In larvæ 7 mm. long all there remains of the yolk and periblast is a small nodule scarcely larger than the combined bulk of the periblast nuclei which are now all huddled together (figs. 53 to 54).

There is no evidence that these cells had any share in forming the blood corpuscles. The yolk at this late stage is almost entirely surrounded by the liver (fig. 54), but I think it is erroneous to suppose, as Wilson has done, that the liver finally absorbs the yolk. It is still in contact with the sinus venosus and the final absorption is accomplished by the blood as truly as the earlier stages of its absorption before the liver is formed. In this late stage the yolk no longer shows the yolk cells, which are still evident in larvæ 5 mm. long.

Yolk nucleus.—The appearance of this structure at the time of maturity was described under the head of "the mature egg." In sections of stages with 60 and 72 nuclei the yolk nucleus consists of a central denser (more deeply stained) portion which is surrounded by a thinner substance. In other sections of about the same stage the mass is not so divided. In some there are spherical (yolk) bodies scattered through it.

The appearance in many of the stages resembles that of the germinal vesicle of the green eggs. In vertical sections the margin is seen to correspond to the surrounding yolk spheres. Cross-sections of the deeper portions show the same. In a somewhat older stage (fig. 32) the outer part of the mass is continued as a thin layer over the yolk.

A peculiar condition is represented by figure 41, in which there is a large mass corresponding to the original mass, in which there are scattered larger yolk granules. Surrounding this on the yolk side is a deep layer of lighter-stained protoplasm.

About the time of the closing of the blastopore the yolk nucleus disappears. In several eggs in which the blastopore is not yet closed no trace of it can be found, while in one egg stained with fuchsine a number of granules are collected in the region where this mass of protoplasm was situated. These granules are similar to others arranged about the periphery of the yolk, and it is doubtful whether they represent a portion of this mass.

The absorption of this protoplasm must be very rapid, for in but slightly younger stages the whole mass is still present.

Since the above was written, about three years ago, this body, so prominent during the early stages of development of the egg, has been identified by one of my students, Mr. J. W. Hubbard, with the yolk nucleus, which is a conspicuous body in the ovarian eggs from the time they measure 20 μ to maturity. The yolk nucleus originates as an extrusion from the germinal vesicle and reaches the entodermic pole at the time of maturity, when the yolk becomes collected about it.

It was found that during the extrusion of the yolk nucleus the germinal vesicle is reduced in size and amount equal to that of the newly formed yolk nucleus. The extrusion of nuclear matter which takes place here lends weight to the supposition of De Vries and Weismann that definite particles may be extruded from the nucleus into the morphoplasm and control it. The functions the yolk nucleus possessed before extrusion are retained some time after extrusion in large-yolked eggs, and according to the recent theories its functions need not be lost at once, even in those in which its constituent biophors are scattered* at the time or soon after its extrusion from the germinal vesicle.

Significance of the yolk nucleus.—A yolk nucleus, metanucleus, Nebenkern, of one description or another, has been observed in the eggs of all groups of metazoa exclusive of those of the Porifera and of the Echinoderms. While it has been observed in such a variety of animals, the explanations it has received have not been commensurate with its distribution. It is true that a yolk nucleus has not been observed in species whose near relatives have this structure well distinguishable. It very frequently disappears soon after its formation, and we need only go a step farther to a condition when it is distributed through the cytoplasm during its formation, and from this condition there is but a step to the separate extrusion of its constituent parts. This may explain its absence in species whose near relatives have it.

While in many eggs it appears early, in others (*Forskalia*) it is not formed till the time of maturation. In all cases in which its formation has been traced it originates from the nucleus as something cast out without the usual formalities of cell division. Its function has been supposed to be that of yolk formation, but it is found in some eggs in which yolk is never formed or, after all the functions of the egg as a cell, aside from its hereditary functions, have disappeared. It has been supposed to give rise to the follicle, but it sometimes does not appear till the follicle has begun to degenerate. It has been supposed to represent the male element in the egg, and in the case of parthenogenetic ova to replace the spermatozoon, and thus has been attributed with the function later assigned to the second polar globule. This last explanation may have a grain of truth in it, but it is far from being satisfactory.

Moreover, while attempts have been made to homologize every other structure or action of the egg with a structure or action in the spermatozoon, I am not aware that this body has received the same distinction. And yet there arises in the spermatozoon a body called by the same name (Nebenkern) in very much the same manner.

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* While the theory of the germplasm is admirably delineated, some objections to the ideas of a biophor as described by Weismann (The Germplasm, Am. Ed. 1893) may be added here. These objections may be answered by the statement that Weismann is not endeavoring an explanation of life. But it is fair to insist that the definition of the theoretical units should not exclude the possibility of life.

The biophor is said to be the smallest unit which exhibits the primary vital forces, viz, assimilation and metabolism, growth and reproduction by fission. The difference between biophors of various kinds "depends on either the absolute relative number of molecules, their chemical constitution (isomerism included), or their grouping." Both suppositions can not hold. For instance, a particular biophor may be composed of 7 (or any other number) of molecules, 3 of one sort, 3 of another, and 1 of a third sort. It would be impossible for such a biophor to give rise by division to another biophor containing the same number of molecules of the same sort arranged in the same manner.

We must imagine that this biophor during growth appropriates molecules like those composing it until double the original number are present of each particular sort of molecules. A division into two similar halves would thus be made possible, but the character of the biophor, according to the sentence quoted above, would have been changed with each molecule added. Or, we must imagine that all the molecules necessary for the formation of a new biophor are appropriated simultaneously, in which case the biophor would suddenly enlarge to double its normal size. This sudden growth might indeed be the agent causing fission. This last alternative verges dangerously near forbidden ground—*i. e.*, the formation of new biophors outside of the original biophor through the simple presence of the latter, after the manner Nägeli supposed new micellæ to arise.

through the caudal mass (fig. 74) that the mesoderm can not be distinguished over the whole yolk.

The ectoderm forms a layer two to three cells deep over the whole egg. The outer layer of cells is in places well separated from the inner layers, the nuclei are slightly larger than those of the inner layers, and the cytoplasm stains lighter. The neural thickening consists of a solid ridge of cells extending down from the ectoderm to the notochord. From the sections it would appear that there is little difference between different points along this region. The ridge appears deeper just in front of the notochord than elsewhere, and here the lower layer of cells has a columnar arrangement.

The diameters of these embryos are respectively 0·27 mm. and 0·3 mm. The embryo has grown till it fills the shell and with but a slight further increase it hatches, the membrane bursting with the further expansion of the embryo. In other teleosts the hatching process is largely due to the muscular efforts of the embryo, while in this case the muscle cells can scarcely, if at all, be distinguished from other cells at the time of hatching. The yolk measures 158 μ to 200 μ.

I have not been able to secure stages between this and the embryo with six (?) or more protovertebræ, which is hatched.

General development of the larvæ.—At the time of hatching, the tail has not begun to bud out. The larva encircles the entire yolk and is so transparent that it can only be found with a lens. Groups of spermatozoa are found attached to its surface. No lumen has appeared in the intestine and muscles have not begun to be differentiated, so that the larva is entirely incapable of motion.

Shortly after hatching, the head and tail, exteriorly almost identical, sometimes overlap, the body being bent over the yolk (fig. 83). However, the larva rapidly straightens itself if this overlapping is normal at all. The lumen of the intestine appears when 10 protovertebræ have been formed (fig. 77) and Kupffer's vesicle has become enormously enlarged. The muscle cells have now become somewhat elongate, though motion is probably not yet possible. The tail is not yet free and the larvæ measure about 0·6 mm. By the time the larva has reached a length of 0·8 mm. the tail forms a thick blunt projection beyond the yolk and the intestine has a continuous lumen from near the anterior end of the notochord back to the future anus (figs. 78 and 84). The heart is represented by a large mass of cells below the head and about 12 protovertebræ have been formed. A swelling is evident in the gill region and shortly afterwards (by the time the larva is 0·9 mm. long) the first gill-slit is opened. The eye and auditory organs now become more prominent, but no otoliths are formed as yet. About 14 protovertebræ are present in larvæ 0·9 mm. long. Spermatozoa are now found in the intestine, which they reach through the first gill-slit.

If larvæ are examined from this stage till the mouth is formed a stream of the ovarian fluid is usually seen entering the gill-slit and escaping through the anus. This stream is kept in motion by very active cilia in the gullet.

When the larva has reached 1 mm. in length, the tail is formed to a considerable extent and terminates in a blunt lobe. The hypertrophy of the hind gut has begun and reaches some distance beyond the yolk-sack. One of the most peculiar structures of the larva, the enormous yolk-sack, has now become well developed. The yolk is quite minute and lies at the posterior end of this cavity, and all the remaining yolk-sack is utilized as a pericardium (figs. 88 and 90.) The heart is now a simple, slender

Those cells which under certain conditions have the power to reconstruct the whole organism are the sex cells. But it was seen that in the infusorian the macronucleus has its function suspended soon after preparations are made for conjugation and that it entirely disappears after conjugation. The macronuclear functions of the sex cells ought therefore also to become suspended if the comparison between the two organisms is to be complete. This suspension must take place the moment of the ultimate division of the germinal epithelial cell or soon after, and the egg has become irrevocably an egg or the spermatozoon irrevocably a spermatozoon. A partial suspension of these functions is evidenced by the absence of further divisions except during the formation of the polar globules, which in the infusorian are seen to be formed from the micronucleus. The formation of the polar cells may therefore be looked upon as products of the micronuclear elements of the germinal vesicle and do not vitiate the supposed suspension of macronuclear divisions. The macronuclear element of the germinal vesicle is eliminated as the yolk nucleus in eggs, and as the Nebenkern in spermatozoa. In eggs without yolk (*Forskalia*), and whose ovarian history is consequently short, it is eliminated just before maturation, as the metanucleus. In eggs developing a large amount of yolk and whose ovarian history is prolonged it arises at a time corresponding to the maturation of non-yolked species, *i. e.*, at the beginning of yolk formation as the yolk nucleus. In those in which it appears comparatively late (*Forskalia*, *Cymatogaster*) it may remain during some of the early stages of development. In those species in which it appears early it is lost in the yolk long before maturation. I have explained why it may be present in one species and absent in another closely related one. Its suspension of activity need not be sudden, and it is not unlikely that it retains some of its functions in some eggs even after it is expelled from the germinal vesicle, and it may then be active and entirely used up in the building up of the yolk, as has been suggested by a number of observers. That its functions are in some way connected with the yolk is certain from the close association between yolk and yolk nucleus, which has given it its name in eggs.*

The direct nuclear division frequently seen in degenerate tissues extends the possibility of comparison between protozoa and metazoa. Such cells may be compared with infusoria which have passed the period of maturity and in which the micronuclear element, which is always accompanied by indirect division, has been lost.

The reason for the complicated process of cell division seen in karyokinesis is evident in all cases where an exact distribution of the halved chromosomes is essential. In cases like the macronucleus in protozoa and the degenerate cells of metazoa where an exact division can be of no advantage, direct division takes place. I do not mean by this to insist that there is a further comparison than the above between the direct division of the macronucleus and that of degenerate cells of metazoa. The former is primitive.

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* The above account of the yolk nucleus was written before the appearance of Weismann's "The Germplasm." In the phraseology used in this theory I hold that each cell (except the degenerate ones in which direct nuclear division takes place) contains germplasm aside from ids from which all the determinates but those controlling the cell have been removed in carrying the cell to its final destination. All cells, the reproductive cells included, are controlled by determinants which are not directly derived from the ids of germplasm contained in the nucleus but from ids which have been simplified during ontogeny. These simplified ids are removed as the yolk nucleus.

cells have become very different from the hypoblast beneath and have become rearranged. In the caudal swelling the two structures are not separated by any distinct line, and the difference between the cells of the future chorda and the gut are not so well differentiated. In the head the hypoblast underlying the chorda is quite thin; caudad it becomes gradually thicker and finally columnar in arrangement. This columnar region stains darker than the surrounding cells. In the posterior part of this region the columnar hypoblast is raised from the yolk to form a distinct arch, or rather, as is seen in transverse section, a transverse fold raised from the yolk (fig. 73).

The outer edges of this fold are raised a little higher than the median portion, and it extends and gradually disappears backward. The floor of this arch is very largely formed by the yolk, its posterior extension entirely so. Below the arch there are a few cells which are very probably derived from its own roof, from which several cells project (figs. 68–73). This space is the first observed condition of Kupffer's vesicle. Cross-sections show that at this time the hypoblast extends over the greater part of the yolk, if not entirely over it (figs. 71–74; hypoblast cells have nucleoli indicated). Near the middle it is several (5) cells deep over nearly half the circumference of the yolk. It is columnar only below and a short distance on either side of the chorda; latterly it becomes thicker, but thins out again to a thickness of one cell (fig. 72). The section extending through Kupffer's vesicle shows that at its outer margins it extends as short pockets toward the ectoderm. In this fact it resembles very closely the conditions found later in the region of the forming gills, which arise as similar outward extensions from the alimentary tract.

In an embryo just freed from the zona radiata, and which still greatly resembles the stage just described, nine protovertebræ are formed, and the development of the intestine has made great progress. The anterior part of the chorda is well formed, and the hypoblast below it is but one cell deep. Caudad the thickness of the hypoblast increases till it is about five cells deep (fig. 75). In the anterior part, where the hypoblast is but one cell deep, evaginations extend upward and outward toward a point below the fundaments of the ear. These folds are of considerable cephalocaudad extension, reaching in one embryo through nineteen cross-sections (figs. 109, 115). These outpushings are for the most part solid at this stage. The peripheral cells of this structure (the gills) are columnar. The outer layer of cells extends some distance over the yolk. Immediately behind the gill region the method of the formation of the floor of the intestine becomes evident (fig. 110). The upper cells of the hypoblast have a dorsoventral columnar arrangement. The lower cells, on the other hand, have the longer axes of their nuclei in a horizontal position, the edges of the hypoblast having become turned in. No space is at first evident between this lower and the upper layers, the infolding resulting in a solid bilateral mass of cells. The lateral extent of the hypoblast is no longer as great as it was in the preceding stage (figs. 110–112). Farther back, where the ingrowth to form the potential floor of the intestine does not take place until some time later, and where the intestine, as will be seen later, is very wide from the beginning, the hypoblast still extends over a considerable portion of the yolk (figs. 112, 113). The same process of forming the intestine takes place in this region later, *i. e.*, the hypoblast becomes columnar and cells grow from the margin inward to form a layer between the yolk and the main mass of hypoblast cells without at once forming a lumen.

Balbiani has suggested that the yolk nucleus supplies the place of the spermatozoa in the case of the parthenogenetic eggs. I do not know whether it has been found in parthenogenetic eggs or not, but will venture a suggestion.* If, as I suppose, this yolk-nuclear element corresponds to the macronucleus of protozoa, we may imagine a condition in some eggs in which the macronuclear elements or ontogenetic elements, and the micronuclear element or the phylogenetic elements are evenly balanced. In such eggs the macronuclear element (the ontogenetic element) could provide for continued growth and division which in eggs in which the micronuclear element predominates is only provided by the union with the male. The micronuclear element, on the other hand, could provide for the building up of the ancestral form. This explanation seems sufficient to account for parthenogenetic eggs. It is desirable now to reëxamine parthenogenetic eggs with this hypothesis in mind.

The notices of this body in literature have been mostly at haphazard. This or that author says: "I have seen it," and another has given its origin in one egg, while another has endeavored to explain its function in still another. While the literature bearing on this subject is largely incidental, enough has been said to show its presence in such a variety of animals that only a deep rooted explanation is sufficient.

That the yolk nucleus is the lineal descendant of the macronucleus may be doubted. Both are probably similar results due to similar causes. It is certain that the germinal epithelial cells contain both the functions of the micro and the macro nucleus. How have the nuclear substances presiding over these different functions become united in a single nucleus in metazoa? The answer seems evident. Both micro and macro nuclei are derived from a single nucleus. In protozoa they are the product of the second segmentation of the conjugation nucleus. We have here a single segmentation between copulation and macronucleus, whereas in metazoa a large number of segmentations intervene, and in this lies the chief difference. (Two more segmentations intervene in the case of spermatozoa than in the case of ova.) Macro and micro nuclear substances are both found in the germinal epithelial cells because the substances have not yet been separated.

Which of the two second generation nuclei becomes the micro, which the macro nucleus is determined by their position anterior or posterior in the new infusorian.

Bambeke in *Scorpæna scrofa* L. There are other minor points of diffefence that will appear on reading the two accounts.

I have given this full statement of Henneguy's theory to avoid any possible claim of injustice on my part to the propounder of a theory, which in so many points agrees with mine. Space and time do not permit me to consider Bambeke's paper and one by Dr. O. Jordan, 1893. It seems, however, that Jordan has entirely underestimated the significance of the yolk nucleus. It may be true that structures in certain eggs have been described as yolk nuclei, which were not homologous with the yolk nucleus of *Cymatogaster* and of other fishes, or of Batrachians. But this does not warrant the sweeping statement that "the various structures usually grouped together under the name Dotterkern have nothing but the name in common." This seems but trifling with facts. I have explained why the yolk nucleus may not become visible in one species and be present in another closely allied species. The absence is apparent rather than real. But supposing its absence should be real in some cases, that would not in the slightest vitiate the importance of a structure whose wide distribution in metazoa is admitted. Certain fishes do not have ventral fins, and some mammals do not possess posterior limbs, but these facts do not destroy the homology of ventral fins of fishes which do possess them with the posterior limbs of mammals which have these structures. The three papers mentioned in this note give a very complete history of the literature bearing on the yolk nucleus.

* Balbiani's yolk nucleus is not homologous with the structure here considered, and his view is, therefore, not identical with the one here given.

Their structure must therefore be the same at the time of segmentation. We have here a differentiation due to external conditions similar to those found in the differentiation of sex from like cells by external conditions. While in infusoria this differentiation into macro and micro nuclear elements takes place after the division of a whole into two equal halves, the differentiation takes place before division in metazoa.

Comparison between the processes of conjugation in ciliate infusoria (modified from Weismann after Maupas) and of maturation and segmentation in Cymatogaster aggregatus.—The modifications of the male cells are purely theoretical, and modified from the conditions often observed in a number of invertebrates. Nothing is yet known of spermogenesis of *Cymatogaster.* The black circles represent micro or germ nuclei, the blank circles the polar nuclei, the shaded parts the macronuclear elements. Note well that between stages H and A of protozoa there intervenes a large number of generations of nuclei-individuals, and that a similar number of generations of nuclei, all of which collectively represent an individual, intervene between I and a=A in metazoa. In series I the macronuclear elements disappear in stage G, while in series III they do not disappear till much later than stage I. Usually in metazoa they disappear in stage A 2, *i. e.*, before the nucleus from which they have been derived loses its entity. While in series I the macronuclear elements are segregated in stage F or at the beginning of the series of daughter nuclei, in series III this process does not take place till stage A 2 is reached or the end of the series of daughter nuclei or concomitantly with the production of a new mother nucleus; in all the intervening stages between I and A 2 macro and micro nuclear elements are united in the same nucleus.

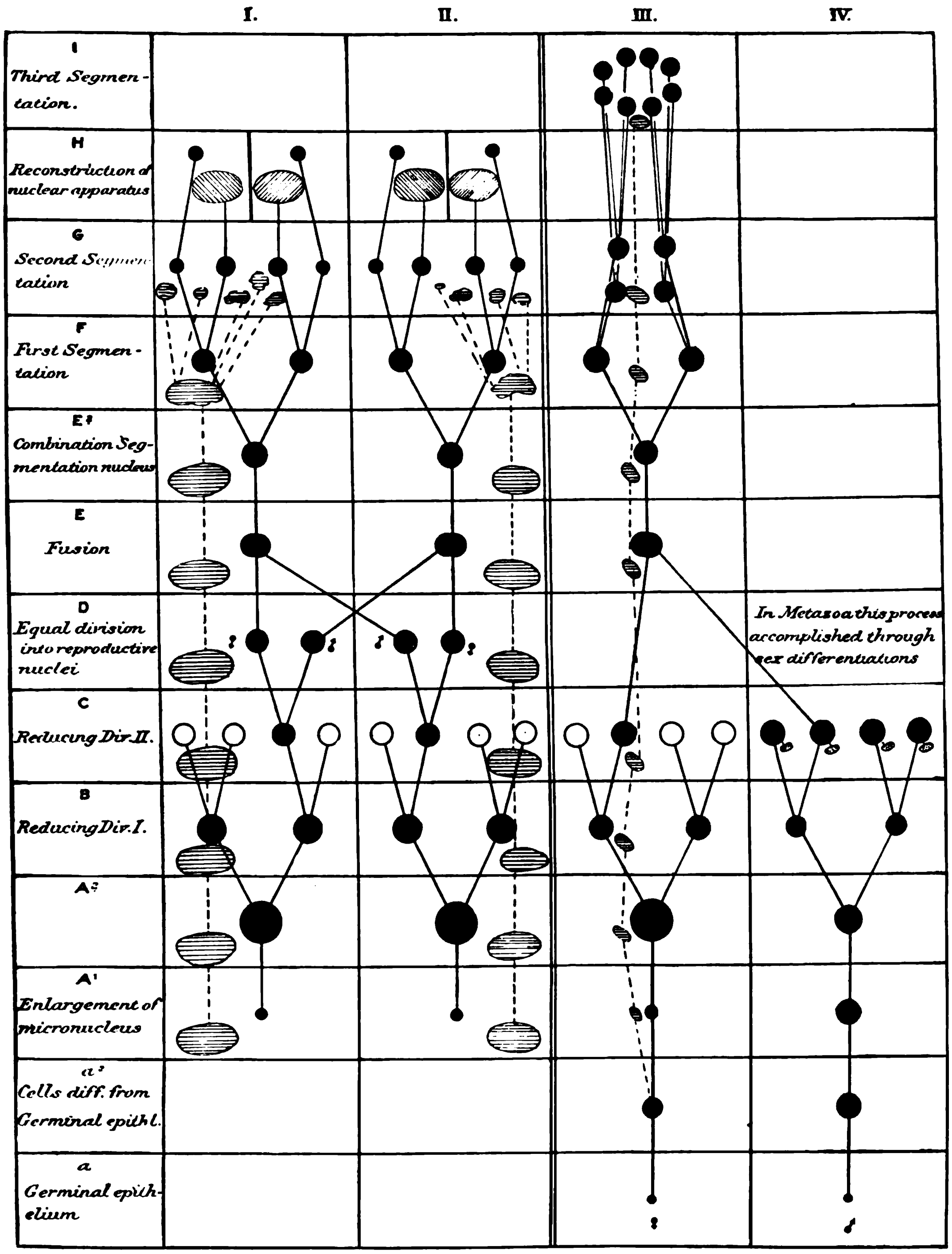
Formation of the mesoderm.—Dr. Minot has said (Am. Nat., 1890, 877): "Scarcely an embryologist can be found who has not published opinions on this question (origin of the mesoderm) considerably at variance with those of most authors." To these already numerous accounts I must add that of *Cymatogaster.* Without question the mesoderm arises here from the entoderm, as has been observed in a number of other fishes by various authors. Instead, however, of being restricted to and arising from a narrow space, it is split off from the entoderm and forms a layer over the whole entoderm, exclusive of the axial line, or the region occupied by the chorda.

Hertwig states, p. 119:

> Bei kinem Wirbelthiere entstehen die Keimblätter durch Abspaltung, sei es vom auseren, sei es vom inneren Grenzblatt, da sie von beiden mit Ausnahme eines sehr beschränkten Keimbezirks überall durch einen Spaltraume scharf abgegrenzt werden.

I have nowhere seen any figures in *Cymatogaster* which favor Hertwig's view of the origin of the mesoderm, and since it apparently appears simultaneously over the whole entoderm exclusive of the middle line, and is closely applied to the entoderm when it usually is widely separate from it, the only explanation tenable seems to be that the mesoderm is split off from the entoderm everywhere except at the median line. In all cases I have been able to examine the entoderm formed a layer beneath the chorda, but I am not positive whether a layer is always present beneath the chorda at the time the latter structure is differentiated, or whether the whole central portion of the entoderm is differentiated into notochord, and a new layer of entoderm is formed beneath this by ingrowth from the sides. The former seems the more probable view.

The development of the chorda and of the mesoderm is still obscure, since I obtained but one or two marked stages between the closing of the blastopore and embryos with three protovertebræ. On reconsideration I am not so certain as to what


I.
II.
III.
IV.
I
Third Segmentation.
H
Reconstruction of nuclear apparatus
G
Second Segmentation
F
First Segmentation
E²
Combination Segmentation nucleus
E
Fusion
D
Equal division into reproductive nuclei
C
Reducing Div. II.
B
Reducing Div. I.
A²
A¹
Enlargement of micronucleus
a²
Cells diff. from Germinal epithl.
a
Germinal epithelium
In Metazoa this process accomplished through sex differentiations
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relation the cephalic end of the embryo bears to the blastopore as I was formerly, but I am inclined to think that in my paper on sex cells I mistook the primitive streak for the head. I am sure that in the embryo with three protovertebræ thus described I mistook the head for the tail. This misconstruction does not affect the results as to the early segregation of the sex cells, but changes their place of origin. The needed corrections to be made in the account of the sex cells will be made in the chapter bearing on this subject. At the closing of the blastopore the embryo usually consists of two layers—the ectoderm and the primitive entoderm. Each of these is several cells deep, and they both extend over the entire yolk, merging into each other at the blastopore. Just before the closing of the blastopore the entoderm is but one cell deep in all places but the axial line. Immediately after the blastopore closes cells are heaped up, probably in the region of the closed blastopore, certainly in the caudal region of the body. With this heaping up of cells the lower and upper layers become merged into a solid mass (figs. 55 to 59). Shortly afterward the mesoderm is split off from the entoderm over the whole of the egg except along this region (figs. 58 to 59).

In some eggs (fig. 43) the mesoderm is not definitely separated from the entoderm after the closing of the blastopore. In others, on the other hand, the mesoderm is at least partly separated even before the closing of the blastopore. In all the sections the mesoderm is seen to be intimately associated with the entoderm, so there can be no doubt as to the source from which it is derived, although the ectoderm at this time is quite thick. Two eggs cut in nearly the same planes and representing the earliest and latest stages found between the closing of the blastopore and the three-protovertebræ stage may be described in some detail. The sections are at right angles to the median plane of the embryo and the first in each of the two embryos is tangential to the primitive streak or thickened caudal mass.

Fig. 55 is the sixth section of the early stage and the first that cuts the yolk. The ectoderm is here several cells deep, being cut obliquely. The outer layer of cells is much lighter than the deeper layer—a fact due to the absorption of the surrounding ovarian fluid. The entoderm is also several cells deep, and at this place no distinction between entoderm and mesoderm can be made out. At the axis the entoderm is much thicker and so intimately joined to the ectoderm that but a very faint line of division is perceptible. The ectoderm at this point is reduced in thickness.

Fig. 56 is the eighth section of the series. The relation of the parts to each other is very much as in the preceding figure. The axial entoderm forms, however, a more rounded mass.

Fig. 57 is the tenth section of the series. This section, being more median, differentiates the parts much better. Over the *ventral* half the outer layer of ectodermal cells is enlarged and much less densely stained; over the dorsal half no such differentiation is seen. Laterally the entoderm is thinner than ventrally and, in places at least, a distinct dividing line can now be seen between mesoderm and entoderm. The axial primitive entoderm is still as important a structure as in the preceding section.

Fig. 58, which represents the twelfth section, differs little from the tenth. The primitive entoderm is still thinner laterally and the distinction between entoderm and ectoderm is still harder to make.

Fig. 59 represents the fifteenth section. All the sections following this are damaged along the axial line. In this section some of the entoderm cells have evidently been misplaced at the embryonic axis, where it is impossible to detect any line sepa-

With the further growth of the vesicle the yolk is usually infringed upon (fig. 145). Whether this is accomplished by the absorption of a part of the yolk, or whether it is simply crowded down, I am not able to say. I am inclined to believe that it is pushed down by the contents of the vesicle; otherwise the rearrangement of the yolk particles would soon fill up the gap made by absorption. However, in later stages of yolk absorption (fig. 136) the yolk is frequently eaten into in very much the same way without any apparent rearrangement of its parts.

After the vesicle has reached its largest size it acquires a cellular floor which corresponds with the *original* outline of the yolk (fig. 146). The vesicle is thus cut in two, a larger yolk vesicle and an upper vesicle which forms the enlarged portion of the hind end of the intestine. The cellular floor seems to be formed by an ingrowth from all sides. Both sagittal and transverse sections show that in earlier stages hypoblast cells extend in below the margin of the vesicle. These would simply have to extend still further centripetally to form a floor for the whole vesicle. The depression in the yolk is at the same time converted into a spherical vesicle, which may be termed the yolk vesicle. It is sometimes partially filled with a brightly staining substance, and as it is quite evident in entire specimens (figs. 84 to 86) I supposed it to be the yolk nucleus before I examined sections and learned the fate of that structure. In one larva the yolk vesicle was found at the ventral side of the yolk (fig. 85). The yolk vesicle remains longer than Kupffer's vesicle, and in fact the intestine extends some distance beyond it before it disappears. There seems to be no regularity in its disappearance, and probably no importance attaches to it after it is separated from the main vesicle.

The cellular floor of the vesicle rapidly thickens as the tail begins to grow out, while its communication with the alimentary canal is maintained (fig. 147). The dome-shaped part is probably constricted off at this time (12 protovertebræ), and the remainder of the vesicle is reduced to the caliber of the rest of the alimentary tract. My sections tell conflicting stories about the exact processes. Figure 78 shows an irregular cavity at the end of the mesenteron, which I consider the remains of the main vesicle. This cavity is connected by an area of disconnected cells with a vesicle lying dorsad of it. Figure 148, on the other hand, in which the tail is not as long as in figure 78, shows a dilation of the intestine dorsad, at the end of which lies a triangular cavity. It would appear that a part of the body of the original vesicle had been constricted off with the dome. The same appears to be true of figure 149. In both these larvæ the cells below this cavity are disarranged. The connection of this dorsal cavity, or vesicle, with the alimentary canal is now represented by the disarranged cells only. The two different structures, vesicle and disarranged cells, may, however, be harmonized. The dorsal vesicle disappears by the proliferation of cells from its wall into its cavity. These cells would at first be expected to be arranged somewhat differently from those in the older structure. In figure 78, which represents the older condition, the process has gone far enough to obliterate all of the body of the vesicle which had remained with the dome.

Neurenteric canal.—Several of the larvæ described above leave no doubt as to the meaning of the dome-shaped structure of Kupffer's vesicle. It is part of the neurenteric canal. In all late stages, as in figure 148, there are fewer cells above the neurenteric canal than in neighboring regions, and in several cases a tubular connection undoubtedly exists between the remains of the dorsal vesicle and the neural region.

In three [illegible] the dorsal [illegible] with cells. [illegible] especially [illegible] where the [illegible] of the ventral [illegible] cells. [illegible] dorsal half [illegible] In another [illegible] of these [illegible] followed. [illegible] probably [illegible] of the [illegible] section. [illegible]

[illegible]

causes which brought about a retardation of the functional intestine would not necessarily affect the functionless postanal section. It thus happens that the postanal vesicle in teleosts appears as Kupffer's vesicle before any lumen is formed in the intestine. In *Serranus*, at least, it lies at the end of a postanal gut. In the trout, according to Henneguy, and in *Cymatogaster* it is at least in part incorporated in the intestine. Kupffer's vesicle is, moreover, the only part of the intestine raised from the yolk before a floor is acquired. [In *Serranus* (Wilson, 1890) this raised portion is not confined to Kupffer's vesicle.] Kupffer's vesicle, in *Cymatogaster* at least, is more than the postanal vesicle of elasmobranchs. The archenteron, the postanal vesicle, and neurenteric canal all seem represented by it.

In *Cymatogaster* it is seen that a part of this vesicle is for a time the direct continuation of the alimentary tube and that during this time a narrow slit (neurenteric canal) extends upward from its anterior half. This upward extension is formed in *Ctenolabrus*, according to Agassiz and Whitman, at the closing of the blastopore. But the condition described by them I have never been able to see in any of the pelagic eggs examined by me.

If we consider a part of the vesicle the homologue of the postanal vesicle of elasmobranchs it remains to be shown why in *Cymatogaster* it forms part of the permanent intestine. The cause is not far to seek. The embryo, in the first place, is shortened on account of the small yolk at the periphery of which it is formed, the tail being represented by a large knob of undifferentiated cells. On the other hand, the alimentary canal is precociously developed, owing to viviparity, and the whole of the hypoblastic area is utilized in forming the permanent alimentary tract.

Agassiz and Whitman (1884) traced Kupffer's vesicle in several species of pelagic eggs. In the formation they found what Kingsley and Conn had already well described. It "arises by the fusion or confluence of a cluster of granules. * * * In *Ctenolabrus* the granules appear soon after the embryonic ring passes the equator, when the length of the embryo is about four-fifths of the diameter of the ovum. Its maximum diameter when fully formed is seldom more than 0·03 mm. During its formation, till it reaches its maximum size, it lies beneath the chorda and the entodermic stratum and has no sort of relation with any tubular structure whatever. * * Ventrally and laterally it is bounded by periblast material. * * * It grows smaller after the closure of the blastopore, and during this period in a number of species it rises from the periblast into the entoderm, where it vanishes." Behind this they have found a variable number of secondary caudal vesicles.

Henneguy (1889) describes some of the distinguishing phases of Kupffer's vesicle in the trout (*Salmo fario.*) (He first described it as early as 1880.) The first indications of a modification in the region of the future vesicle were noticed very early and the vesicle itself was quite large when but two or three protovertebræ had been formed. The cells in this region are larger than the others and are undergoing division. There are but few of these cylindrical cells, and they are in contact with the periblast, and later one sees "une invagination se produise dans l'embryon pour former la vésicule." This mass of cells is the first indication of Kupffer's vesicle. Its growth must be quite rapid, for it is 0·11 mm. long and 0·09 wide when but two or three protovertebræ are formed, and occupies "la place de la corde dorsale," *i. e.*, it is entirely surrounded by hypoblast. It lies just in front of the caudal swelling "au point où commence à se differencier le mésoderm." He points out that it differs in its position in the entoderm

Some of the cells of the floor of the intestine may be derived from the roof directly. If so, such cells are derived from the region just below the chorda (fig. 127) and demonstrate the bilateral condition of the enteron. The same bilateral condition becomes still more evident later, when frequently two lumina make their appearance, especially in the anterior region (fig. 122). Kupffer's vesicle has now become much larger (figs. 75, 110, 113), but since it is such a striking feature of the stages succeeding the one under consideration it will be dealt with in a separate chapter.

In a slightly older larva (fig. 76), which differs from the one just described in being straightened out, the hypoblast presents in a sagittal section the same appearance seen in the preceding stage. But a layer of horizontal cells is now present between the yolk and the main mass of hypoblast (figs. 117, 125, 126, 127). In other words, the ingrowth of hypoblast has now reached the median line, and the floor of the enteron has been completed. Transverse sections demonstrate the completion of the floor in the whole of the postcephalic region exclusive of Kupffer's vesicle, which is now a very large cavity (fig. 76).

Soon after the completion of the floor as far as just described, the lumen appears both anteriorly and posteriorly (fig. 77). It is formed by the separation of the two layers of cells already formed. The separation usually begins laterally and grows towards the middle line. This is especially true of the cephalic portion (figs. 121, 122, 127, 130). In the front part of the body the hypoblast is about as high as wide (figs. 23, 130, 131), while in the posterior region it is many times as wide as high, encircling the whole of this portion of the yolk, and the lumen formed here is a Λ-shaped slit with very long arms, and occasionally an upward extension at the median line (figs. 124, 133, 134). The posterior lumen is, therefore, from the first potentially very wide, for as soon as the lower layer is separated from the upper to its full extent the intestine is relatively very large in this region.

As stated above, the lumen is formed in front and behind simultaneously. The *gullet or middle region remains a solid rod* (figs. 77, 131, 132). This appearance led me at first to suppose that the posterior intestine is precociously developed; but, as we have seen, the floor of the entire intestine is formed continuously from before backward, and the solid mass is the result of the retardation of the formation of the lumen between the two layers of the hypoblast, after such a separation has taken place in front and behind. I am not aware that a similar condition has been found in other teleosts more than once before. A similar condition is, however, described by Balfour (Elasmobranch Fishes, p. 217) for elasmobranchs. In elasmobranchs the œsophagus has a well-developed lumen like the remainder of the alimentary tract, but "its lumen becomes smaller and finally vanishes, and the original tube is replaced by a solid rod of uniform and somewhat polygonal cells." Although a lumen does not at first appear in *Cymatogaster*, its equivalent does, if we bear in mind that the floor is formed after the exact method used in elasmobranchs to form a lumen, *i. e.*, by the ingrowth below of the marginal cells of the hypoblast. What morphological significance this retrogressive development of the part of the intestine in elasmobranchs and in teleosts has I am unable to suspect, unless indeed Balfour's conjecture (II, 61) may be correct. He has found a solid œsophagus in the salmon (sp.) long after hatching. "It appears not impossible that this feature in the œsophagus may be connected with the fact that in the ancestors of the present types the œsophagus was perforated by gill-slits; and that in the process of embryonic abbreviation the becomes narrower and higher, and the cells at the same time lose their great height and their cilia; just behind the gill swelling the lumen is subcircular or horizontally oval. Its walls are composed of a single layer of cells but 5μ high. Still farther back the lumen becomes vertically oval, and the cells of the floor lose their columnar nature and multiply so that a thickened floor is formed. The change in shape of the lumen (159 and 160) is due to a longitudinal groove, shallow in front, becoming deeper behind, abruptly stopping still farther back just in front of the hind gut. Behind this place the lumen is again contracted. This ventral groove and thickening of the floor is the rudiment of the liver. The region through which this groove extends is quite extensive, reaching through 19 sections of the 85, making up the entire length of the intestine, or through almost the entire region from the ciliated gullet to the hind gut (fig. 162). A short distance behind the pronephros another thickening appears in the walls of the intestine, this time in the roof, which is at the same time extended laterally (fig. 160). This upper thickening is not so extensive, reaching through 10 sections and extending in the early condition as far back as the lower mass. This upper thickening is the rudiment of the air bladder. The mesoderm surrounding the alimentary tract in these regions is also considerably thicker than in other regions. At the beginning of the ventral groove the lumen of the intestine has a diameter of 45μ, the cells a height of 9μ. At the end of the groove the lumen has a diameter of 68μ, and the cells lining it have a height of 13μ. Just behind the groove the height of the lumen is again reduced to 45μ. From this point the intestine rapidly widens till it reaches a diameter of 160μ (fig. 161). The cells lining this portion are 22μ high. Just in front of the anus the lumen becomes a vertical slit and the inner layer of the ectoderm becomes reinforced along the ventral line to form a keel. For four sections the anus is a vertical slit, the sides of which flare outward below. Behind the slit it is continued as a median groove with equally flaring sides, on the crests of which the nephridial ducts empty. On either side of the vertical portion of the intestine, just in front of the anus, the splanchnic and the somatic mesoblast are united in a solid mass in which the sex cells are embedded. Behind the anus a short, solid cord of hypoblast extends into the tail, between the aorta and the caudal vein. In older larvæ the ridges behind the anus meet in the median line and the segmental ducts thus come to empty in the median line. The relations of the liver to the air-bladder in older larvæ may be gathered from figs. 162 and 163. Their further development in a larva 2·5 mm. long is shown in fig. 165, where the gall-bladder has begun to develop.

In larvæ a little over 3 mm. long, the thyroid gland and the hypophysis are well along in their development. These larvæ measured 3·2 mm. after hardening, and were probably longer in life. The intestine (figs. 166 to 174) has not changed much except in the regions of the gills. The lumen extends forward to in front of the thyroid gland. Anterior to this point the two layers of hypoblast cells are still in contact with each other. The mouth has, however, become evident laterally, as will be seen from fig. 169. The anterior opening of the intestine is still the hyobranchial gill-slit. The ciliated gullet has now reached its full development. In the entire gill region the intestine is depressed; its width decreases in this region from 181μ to 112. Behind the gullet it dwindles to a diameter of but 22μ; in the hind gut it reaches 136. In the anterior gill region the walls of the enteron are less than 4μ thick and consist of a layer of pavement cells unquestionably of hypoblast origin and of a layer of very thin cells (fig. 172). This thinner layer I take to be ectodermal cells come in contact with them they are whirled about so that the presence of cilia becomes very evident. In later stages they become conspicuous in sections and smaller cilia seem also to be formed in the wider parts of the intestine, but I have not been able to demonstrate them in sections.

Cilia have recently been described in the intestine of fishes by McIntosh and Prince, 1891, p. 772: "Many preparations show a lining apparently of cilia, and there is thus great probability that the enteric tract—the œsophageal portion at least—of young teleosteans is ciliated."

The intestine is now a single tube from the hyobranchial slit to the anus, with four well-defined regions: the gill-cavity into which the gill-slit opens, the ciliated gullet, a narrow indifferent region (the future stomach), and the wide hind gut with high columnar cells. So far none of the glands to be derived from the enteron have appeared. The liver and air-bladder appear in the stages immediately succeeding the one described in the third region enumerated. The hypophysis and the thyroid gland are derived still later from the lining of the buccal cavity and the hypoblast extending forward from this region.

Before describing the further development of the alimentary tract it will be necessary to go back and follow the modifications of Kupffer's vesicle which, at the last stage described, has disappeared.

Historical on alimentary canal.—Hoffmann, 1882, p. 5, found the hypoblast to consist of a single layer of spindle-shaped cells whose lateral extent was not equal to that of the mesoderm. He found the tube to be formed from in front backward. In the head region the hypoblast has a great lateral extent, and it is here that two lateral infoldings occur. The second or lower layers so formed grow toward each other till they meet. The two layers lie close upon each other, so that a lumen is not evident from the first. The gills are formed by a still further outgrowth in definite regions and are developed from in front backward. He considers the formation in the region of the ear-capsule peculiar, since the hypoblast which is here folded first of all extends *upward* so that it lies close to the auditory vesicle. These outpushings move forward later when the gill formation has begun and finally break through to the outside and form a larval spiracle. It soon disappears. In the trunk the intestine is formed by two infoldings, as in the head, but the hypoblast is much more restricted laterally and the intestine consequently much narrower. A lumen does not appear at once, and this is formed in the hind gut first.

Agassiz and Whitman, 1884, found the secondary entoderm one cell deep. This is divided into two masses by the chorda, but the two parts unite below the chorda later. About the time the blastopore closes the strip beneath the chorda becomes two or three cells deep. This thickened mass gives rise to the alimentary canal, but how the tube is formed they were unable to say.

Henneguy, 1884, found in the trout (*Salmo fario*) that at the time of the differentiation of the secondary entoderm it is composed of one or two layers of cells. (Later, p. 122, he says three or four.) During a stage with from 12 to 18 protovertebræ, when Kupffer's vesicle is well formed, the entoderm begins to become infolded below the anterior end of the notochord to form the intestine. The entoderm at this time extends forward to in front of the auditory vesicle. It is raised on each side of a median line, below the auditory vesicle, and it is here that the first infolding becomes evident. The infolding at this time does not extend beyond the anterior third of the

need but continued conditions, such as exist in the ovary for the hyobranchial cleft, to entirely replace the present mouth. To discover where the primitive mouth was is quite another question. We may assume that it opened into the gill-cavity in the region of the first gill-slit, since here a lumen exists long before it is formed forward. In this connection a strand of hypoblast cells extending up from the wall of the intestine in the median line just in front of the chorda becomes of great interest. It is indicated quite early (fig. 152), or as soon as the lumen is continuous from the gill-slit to the anus, and it is still striking in larvæ over 3 mm. long (fig. 166), after which it gradually disappears. This structure is not connected with the gills nor have I been able to connect it with the history of any other structure. This strand of hypoblast cells may indeed be the vestige of the primitive gullet. I have so far not been able to trace it through or even into the brain.

The thyroid gland and the hypophysis make their appearance when the larvæ are about 1·8 mm. long. The thyroid appears as a thickening in the ventral layer of hypoblast just in front of the anterior end of the heart (figs. 171*b* and 171*c*). The hypophysis is somewhat different from the start. The cells of the roof become columnar and several layers thick and a refold is formed. This condition is well demonstrated in fig. 166.

Shortly afterward the infolded cells are constricted off from the rest of the hypoblast and lie as an independent structure at the base of the brain (fig. 177).

Gills.—The formation of the first gill-slit has been described in connection with the intestine, and the hyomandibular and mandibular slits have also been considered. It remains now to trace the formation of the posterior slits. Soon after the formation of the hyobranchial a thickened mass is formed behind it; this mass extends out beyond the outline of the body of the embryo, and owing to its well-defined limits is conspicuous in the living larva (figs. 83–91) as well as in sections. (Figs. 137, 139, 150–157, 172 to 174.)

This mass is largely composed of mesoblastic cells. It grows very rapidly and from it are derived the skeleton and the soft parts of the gill-arches. The gill-clefts arise as pouches extending out from the entoderm. These may be met by shallow ingrowths of ectoderm (fig. 150, *br.* 8). The pouches are formed from the hyobranchial backward. They seem to be somewhat irregular at first and hollow (figs. 151 and 156), but later the layers of hypoblast forming them are closely appressed, all the space between them having disappeared. The second is forming when the larva is about 1 mm. long (figs. 136 and 137); the third when it has reached a length of 1·8 mm. These measurements are after hardening; the living larvæ were probably somewhat longer.

The fifth slit is nearly completed at 2·5 mm. Though the slits are potentially completed so early, the two layers of hypoblast composing them are not separated from each other till the larvæ have attained twice this length. They are seen to be separating in a larva 4 mm. (fig. 137). The slits are not vertical, but extend downward and forward. In the early stages the thickened mass containing the rudiments of the gills are entirely lateral. Below there is but a single layer of mesoderm (139). After the potential slits have been formed the mesoderm between them grows downward and forward till it reaches nearly the median line in larvæ a little over 3 mm. long.

of the hind gut, which, however extends even further in later stages, the anus forming some distance behind the original place of the vesicle. The lower one remains for some time as a space in the yolk and the upper one is pushed upward and disappears through a proliferation of the cells of its wall when about fifteen protovertebræ have been formed. I will describe the successive phases of this structure as they could be made out by my material. The conditions described by Henneguy for the trout approach nearer those of the middle vesicle of *Cymatogaster* than any others made known so far.

As stated above, Kupffer's vesicle makes its appearance early; when three protovertebræ have been formed it is a well-defined structure. Before this stage it has not been seen. At this time it is a broad, short, low space between the yolk and the hypoblast, a short distance behind the end of the notochord. The hypoblast cells forming its roof are high columnar. The greater part of the floor is composed of the yolk, but in a few places cells are also found on the floor of the vesicle, but these are not regularly arranged. (Longitudinal sections 67, 68, 70; cross-section, fig. 73.) The columnar arrangement of the hypoblast cells is continued forward for some distance in front of the vesicle. The antero-posterior extent of the vesicle is much less than its lateral extent. The outer angles of the vesicle are pushed slightly upward and outward, giving the roof an angular appearance and greatly resembling the conditions of the gills in slightly older larvæ. For these reasons I at first considered this stage of Kupffer's vesicle as the first indication of the lumen of the alimentary canal in the region of the gills.

In a larva with ten protovertebræ it has become a large shallow subcircular cavity in the entoderm and is still floored by the yolk. From its roof a small dome-shaped cavity extends still deeper into the indifferent or hypoblastic mass of cells forming this part of the larva. The contour of the yolk is not affected by the vesicle (fig. 75). The cells in the tail of this larva are somewhat disarranged, so that the relations of the vesicle with the surrounding structure can not be definitely made out. It is, however, only in this region that the entoderm and yolk are not in close contact. The lumen of the intestine has nowhere appeared as yet.

The larva at this time forms an almost complete circle around the yolk. As the larva is straightened out and the lumen of the intestine is formed, and even before any lumen appears (fig. 76), Kupffer's vesicle enlarges rapidly. The arrangement of the entoderm cells in front of the vesicle shows that it is from the first an enlarged portion of the alimentary tract, which remains without a floor long after a floor is formed in all other parts. At this time the vesicles differ greatly in shape in different specimens, but all the larvæ examined show the following structure:

First. A low cavity in the entoderm with considerable lateral extent. Its dorsal wall of columnar hypoblast is a direct continuation of the roof of the alimentary tract.

Second. A dome-shaped cavity usually in the anterior half of the vesicle extending dorsad (figs. 76, 77, 144). This dome-shaped portion, which was evident in the earlier stage, forms, as will be seen later, the lower half of the neurenteric canal.

Up to this stage the vesicle is formed exclusively at the expense of the entoderm which surrounds it above and on the sides, and frequently forms a floor at the margin of the vesicle. The contour of the yolk has not been affected. Over the center of the dome the cells are usually somewhat irregularly placed as compared with those of its sides, but a neurenteric canal I have not been able to find in this stage.

With the further growth of the vesicle the yolk is usually infringed upon (fig. 145). Whether this is accomplished by the absorption of a part of the yolk, or whether it is simply crowded down, I am not able to say. I am inclined to believe that it is pushed down by the contents of the vesicle; otherwise the rearrangement of the yolk particles would soon fill up the gap made by absorption. However, in later stages of yolk absorption (fig. 136) the yolk is frequently eaten into in very much the same way without any apparent rearrangement of its parts.

After the vesicle has reached its largest size it acquires a cellular floor which corresponds with the *original* outline of the yolk (fig. 146). The vesicle is thus cut in two, a larger yolk vesicle and an upper vesicle which forms the enlarged portion of the hind end of the intestine. The cellular floor seems to be formed by an ingrowth from all sides. Both sagittal and transverse sections show that in earlier stages hypoblast cells extend in below the margin of the vesicle. These would simply have to extend still further centripetally to form a floor for the whole vesicle. The depression in the yolk is at the same time converted into a spherical vesicle, which may be termed the yolk vesicle. It is sometimes partially filled with a brightly staining substance, and as it is quite evident in entire specimens (figs. 84 to 86) I supposed it to be the yolk nucleus before I examined sections and learned the fate of that structure. In one larva the yolk vesicle was found at the ventral side of the yolk (fig. 85). The yolk vesicle remains longer than Kupffer's vesicle, and in fact the intestine extends some distance beyond it before it disappears. There seems to be no regularity in its disappearance, and probably no importance attaches to it after it is separated from the main vesicle.

The cellular floor of the vesicle rapidly thickens as the tail begins to grow out, while its communication with the alimentary canal is maintained (fig. 147). The dome-shaped part is probably constricted off at this time (12 protovertebræ), and the remainder of the vesicle is reduced to the caliber of the rest of the alimentary tract. My sections tell conflicting stories about the exact processes. Figure 78 shows an irregular cavity at the end of the mesenteron, which I consider the remains of the main vesicle. This cavity is connected by an area of disconnected cells with a vesicle lying dorsad of it. Figure 148, on the other hand, in which the tail is not as long as in figure 78, shows a dilation of the intestine dorsad, at the end of which lies a triangular cavity. It would appear that a part of the body of the original vesicle had been constricted off with the dome. The same appears to be true of figure 149. In both these larvæ the cells below this cavity are disarranged. The connection of this dorsal cavity, or vesicle, with the alimentary canal is now represented by the disarranged cells only. The two different structures, vesicle and disarranged cells, may, however, be harmonized. The dorsal vesicle disappears by the proliferation of cells from its wall into its cavity. These cells would at first be expected to be arranged somewhat differently from those in the older structure. In figure 78, which represents the older condition, the process has gone far enough to obliterate all of the body of the vesicle which had remained with the dome.

Neurenteric canal.—Several of the larvæ described above leave no doubt as to the meaning of the dome-shaped structure of Kupffer's vesicle. It is part of the neurenteric canal. In all late stages, as in figure 148, there are fewer cells above the neurenteric canal than in neighboring regions, and in several cases a tubular connection undoubtedly exists between the remains of the dorsal vesicle and the neural region.

In three cases (78, 148, 149) the dorsal portion is wholly or partly filled with cells. This is especially well seen in fig. 78, where the boundaries of the dorsal half of the canal are as well marked as those of the ventral half, but in which the dorsal half contains cells. The same is true of another larva (fig. 148), but in this instance the walls of the dorsal half are not so well defined. In another larva (fig. 149) a narrow but well-defined canal extends from the remains of the vesicle upward and then curves forward. This is probably only the posterior wall of the neurenteric canal. More or less well-defined lines extend from the anterior portion of the dome upward. The same condition can be traced in series of transverse sections. There seems then to be but little room for doubt about this structure. All the evidence indicates that in part at least it is the neurenteric canal.*

Kupffer's vesicle in general.—Kupffer's vesicle is evidently a rudimentary structure, without function in the majority of fishes. Several quite distinct views have been held as to the significance of this structure.

Kupffer, who first described it, and recently Henneguy, considered it to be the allantois of higher vertebrates.

Balfour homologized it with the postanal vesicle of elasmobranchs.

Cunningham, Ziegler, McIntosh and Prince, consider it to represent the invaginated gastrula (archenteron) of cyclostomes and plagiostomes.

Kowalewski holds in the main to the same opinion.

Henneguy formerly considered it the homologue of the primitive intestine of cyclostomes and amphibians. Many others who have seen the structure are noncommittal as to its significance.

The variety of opinions may in part be due to the variation of this structure in different fishes, for there is no doubt about the variability of the vesicle. It is difficult to see how a waning structure can represent a condition that has not appeared before phylogenetically and does not appear till in much higher vertebrates. I can not see how it can represent the allantois. Cunningham's theory is based on the presence of a canal between the vesicle and the blastopore. This canal is certainly not present in *Cymatogaster*, where the vesicle does not appear till long after the blastopore is closed.

Wilson considers the early stages homologous with the terminal part of the archenteron of amphibians and the later stages homologous with the postanal vesicle of elasmobranchs.

The fact that in the majority of fishes it arises long before the alimentary canal and disappears, or at least diminishes, before the alimentary canal is formed argues against its homology with the postanal vesicle of elasmobranchs. It must be conceded, however, that in fishes the alimentary canal is late in making its appearance as compared with elasmobranchs. The alimentary tract is retarded in teleosts for some reason or other. The caudal vesicle is functionless in elasmobranchs and the

causes which brought about a retardation of the functional intestine would not necessarily affect the functionless postanal section. It thus happens that the postanal vesicle in teleosts appears as Kupffer's vesicle before any lumen is formed in the intestine. In *Serranus*, at least, it lies at the end of a postanal gut. In the trout, according to Henneguy, and in *Cymatogaster* it is at least in part incorporated in the intestine. Kupffer's vesicle is, moreover, the only part of the intestine raised from the yolk before a floor is acquired. [In *Serranus* (Wilson, 1890) this raised portion is not confined to Kupffer's vesicle.] Kupffer's vesicle, in *Cymatogaster* at least, is more than the postanal vesicle of elasmobranchs. The archenteron, the postanal vesicle, and neurenteric canal all seem represented by it.

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* I want to point out here the possibility that the neurenteric vesicle alone represents the caudal vesicle of other teleosts, and that its connection with the lower part of the vesicle which is converted into the hind gut is after all due to the precocious development of the hind gut, which thus extends past the region of the original Kupffer's vesicle before the growth of the tail has carried the latter farther back. In that case the postanal gut would be represented by the dorsal wall of the hind gut; *i. e.*, the region between the hind gut and the neurenteric vesicle. This would account for the fact that I have not been able to find any other structure which might be homologized with the postanal gut frequently described for teleosts. The lower or main part of the vesicle may then be looked upon as the archenteric cavity.

In *Cymatogaster* it is seen that a part of this vesicle is for a time the direct continuation of the alimentary tube and that during this time a narrow slit (neurenteric canal) extends upward from its anterior half. This upward extension is formed in *Ctenolabrus*, according to Agassiz and Whitman, at the closing of the blastopore. But the condition described by them I have never been able to see in any of the pelagic eggs examined by me.

If we consider a part of the vesicle the homologue of the postanal vesicle of elasmobranchs it remains to be shown why in *Cymatogaster* it forms part of the permanent intestine. The cause is not far to seek. The embryo, in the first place, is shortened on account of the small yolk at the periphery of which it is formed, the tail being represented by a large knob of undifferentiated cells. On the other hand, the alimentary canal is precociously developed, owing to viviparity, and the whole of the hypoblastic area is utilized in forming the permanent alimentary tract.

Agassiz and Whitman (1884) traced Kupffer's vesicle in several species of pelagic eggs. In the formation they found what Kingsley and Conn had already well described. It "arises by the fusion or confluence of a cluster of granules. * * * In *Ctenolabrus* the granules appear soon after the embryonic ring passes the equator, when the length of the embryo is about four-fifths of the diameter of the ovum. Its maximum diameter when fully formed is seldom more than 0·03 mm. During its formation, till it reaches its maximum size, it lies beneath the chorda and the entodermic stratum and has no sort of relation with any tubular structure whatever. * * Ventrally and laterally it is bounded by periblast material. * * * It grows smaller after the closure of the blastopore, and during this period in a number of species it rises from the periblast into the entoderm, where it vanishes." Behind this they have found a variable number of secondary caudal vesicles.

Henneguy (1889) describes some of the distinguishing phases of Kupffer's vesicle in the trout (*Salmo fario.*) (He first described it as early as 1880.) The first indications of a modification in the region of the future vesicle were noticed very early and the vesicle itself was quite large when but two or three protovertebræ had been formed. The cells in this region are larger than the others and are undergoing division. There are but few of these cylindrical cells, and they are in contact with the periblast, and later one sees "une invagination se produise dans l'embryon pour former la vésicule." This mass of cells is the first indication of Kupffer's vesicle. Its growth must be quite rapid, for it is 0·11 mm. long and 0·09 wide when but two or three protovertebræ are formed, and occupies "la place de la corde dorsale," *i. e.*, it is entirely surrounded by hypoblast. It lies just in front of the caudal swelling "au point où commence à se differencier le mésoderm." He points out that it differs in its position in the entoderm

from the condition usually prevailing in fishes where it projects into the vitellus. He then states that this difference is of no importance (1881), for in a later stage the vesicle "peut faire saillie hors de l'embryon" and thus become as in other fishes. In other words, the process described by Agassiz and Whitman is here said to be inverted. In a stage with twenty-two protovertebræ it is figured as the enlarged posterior end of the alimentary canal. It would here, then, permanently form a part of the intestine, and in this respect agree with the middle vesicle in *Cymatogaster*. It elongates anteroposteriorly and becomes pyriform. It comes directly in contact with the nervous thickening above. It is only the first indication of the digestive tube. It is important on account of its relation with the nervous system and the notochord and the region corresponds to the region of the neurenteric canal of other vertebrates. He has never found a canal leading to the exterior. He considers the opinion of Kingsley and Conn, Agassiz and Whitman, Cunningham, Ziegler, that the vesicle lies between the periblast and the hypoblast, to be based on an error of observation.

Frequently there exists below the vesicle or in its neighborhood a hemispherical depression in the surface of the vitellus. (It is possible that in this case the vesicle divides into two, a yolk vesicle and the intestinal vesicle seen in *Cymatogaster*.) He thinks the original opinion of Kupffer may still be defended when one considers that it is the first indication of the alimentary canal in the neurenteric region and that the allantois of higher vertebrates is but a diverticulum of the intestine appearing very early in front of the neurenteric canal.

In *Serranus*, according to Wilson, the vesicle appears as an up-pushing of the hypoblast, which had previously become columnar, and a down-pushing of the periblast. It disappears by the proliferation of cells from its own walls. It is formed some distance behind the future anus and lies in the postanal gut. In this respect it greatly resembles the postanal vesicle of elasmobranchs, with which it is homologous. "Before Kupffer's vesicle is folded off it represents the terminal dilatation of the archenteron itself, and in this phase is to be compared with the dilated posterior extremity of the archenteron in certain amphibian gastrulas."

McIntosh and Prince (1890) observed the vesicle in a number of species. They find that it arises, as Kingsley and Conn have described, by the union of a number of granules or small vesicles. They found secondary vesicles quite frequently, sometimes extending "all along the ventral line almost to the pectoral region." Its contents are usually homogeneous and clear, though granules are occasionally present. They claim to have traced a neurenteric canal from the vesicle to the blastopore at the time the latter closes.

Formation of liver and air bladder, mouth, thyroid gland, and hypophysis.—In a preceding chapter the intestine was described from its first appearance until, in larvæ 1 mm. long, it forms a simple tube from the hyobranchial gill-slit to the anus. In the stages succeeding that the rudiments of the liver and of the air-bladder make their appearance. Parts of the tract are at the same time otherwise modified.

In larvæ 1·8 mm. long (figs. 150, 156, 157) the intestine is broad and depressed just behind the hyobranchial slit, and its walls are composed of ciliated cells 18μ high. In the roof the nuclei of the cells are slightly nearer the free ends of the cells and nearly all are on the same level.

In the floor there are besides this layer of cells a few scattered ones among the bases of the others (figs. 156, 157). Towards the back part of the gullet the lumen

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between the mesoderm and ectoderm. In the anterior region the cells of the neurula (fig. 65) are seen to radiate from the dorsal depression.

The ectoderm is everywhere about three cells deep. The outermost layer is differentiated into a flattened epithelium.

While the relation of the head end of the embryo to the blastopore can not be certainly decided, it seems probable that at this period the embryo encircles considerably more than half a circumference of the yolk. The length of the embryo is now increased, chiefly at the expense of the caudal mass of cells.

Anatomy of an embryo with three protovertebræ.—Of this stage I have two good series of sections. One of the embryos was cut in the sagittal plane, the other at right angles to it. The former was figured (figs. 5, 6) in my account of the sex cells, but the anterior was mistaken for the posterior.

The entoderm in this stage forms a layer over nearly the entire yolk. The only region where it could not be distinguished was over the small portion of yolk between the caudal mass of cells and the head of the embryo. In the anterior region it gradually merges into the one-cell-deep mesoderm. Along the axial line, beneath the notochord, the entoderm is about two cells deep. Just to one side of this median line the entoderm is three or four cells deep; at the sides of the yolk it dwindles to an attenuated layer but one cell deep (figs 72, 73), and along the ventral line it is merged with the mesoderm. In longitudinal sections the entoderm is still evident, even in this region (fig. 67). Just in front of the caudal region, where the three layers merge into each other, the entoderm has a columnar arrangement and is raised some distance from the yolk (fig. 68 *kv*). This is the first indication of Kupffer's vesicle. In cross-section the raised region is seen to be quite wide, with the outer angle projecting upward and outward (fig. 73). The further development of Kupffer's vesicle will be described in another chapter.

The principal difference between the entoderm of *Cymatogaster* and other teleosts during this stage lies in the fact that it is composed of several layers of cells and that it covers the greater part if not the whole of the yolk.

The notochord is well formed and has assumed its final outline back to the neurenteric region, where its outlines merge into the general mass. In front it tapers to a point. The notochordal cells are as yet but little different from the cells of the other structures. The outlines of the nuclei and of the cell itself are a little more prominent and the cells are anteroposteriorly compressed. This gives their nuclei in the sagittal section (67) vertical oval outlines and gives the impression that the cells have a vertical columnar arrangement which they do not in reality have.

The mesoderm consists of a single layer of cells in the anterior cephalic region (fig. 71). It rapidly thickens backward on either side of the notochord and neural ridge (fig. 70). The cephalic region, or the region in front of the first protovertebræ, is about the third of the entire length. There is no cavity in the protovertebræ, but the nuclei are arranged in an epithelial manner around a central region. The three protovertebræ extend over one-fifth of the length of the embryo. In the embryo cut in a sagittal direction the mesoderm just behind the third protovertebra contains numerous sex cells; behind these the mesoderm disappears as a distinct layer. From the thickened masses along the notochord the mesoderm extends over the yolk in all directions, thinning out to two and further laterally to a single layer of cells, the two sheets meeting along the ventral line of the embryo. It is only in cross-sections

need but continued conditions, such as exist in the ovary for the hyobranchial cleft, to entirely replace the present mouth. To discover where the primitive mouth was is quite another question. We may assume that it opened into the gill-cavity in the region of the first gill-slit, since here a lumen exists long before it is formed forward. In this connection a strand of hypoblast cells extending up from the wall of the intestine in the median line just in front of the chorda becomes of great interest. It is indicated quite early (fig. 152), or as soon as the lumen is continuous from the gill-slit to the anus, and it is still striking in larvæ over 3 mm. long (fig. 166), after which it gradually disappears. This structure is not connected with the gills nor have I been able to connect it with the history of any other structure. This strand of hypoblast cells may indeed be the vestige of the primitive gullet. I have so far not been able to trace it through or even into the brain.

The thyroid gland and the hypophysis make their appearance when the larvæ are about 1·8 mm. long. The thyroid appears as a thickening in the ventral layer of hypoblast just in front of the anterior end of the heart (figs. 171*b* and 171*c*). The hypophysis is somewhat different from the start. The cells of the roof become columnar and several layers thick and a refold is formed. This condition is well demonstrated in fig. 166.

Shortly afterward the infolded cells are constricted off from the rest of the hypoblast and lie as an independent structure at the base of the brain (fig. 177).

Gills.—The formation of the first gill-slit has been described in connection with the intestine, and the hyomandibular and mandibular slits have also been considered. It remains now to trace the formation of the posterior slits. Soon after the formation of the hyobranchial a thickened mass is formed behind it; this mass extends out beyond the outline of the body of the embryo, and owing to its well-defined limits is conspicuous in the living larva (figs. 83–91) as well as in sections. (Figs. 137, 139, 150–157, 172 to 174.)

This mass is largely composed of mesoblastic cells. It grows very rapidly and from it are derived the skeleton and the soft parts of the gill-arches. The gill-clefts arise as pouches extending out from the entoderm. These may be met by shallow ingrowths of ectoderm (fig. 150, *br.* 8). The pouches are formed from the hyobranchial backward. They seem to be somewhat irregular at first and hollow (figs. 151 and 156), but later the layers of hypoblast forming them are closely appressed, all the space between them having disappeared. The second is forming when the larva is about 1 mm. long (figs. 136 and 137); the third when it has reached a length of 1·8 mm. These measurements are after hardening; the living larvæ were probably somewhat longer.

The fifth slit is nearly completed at 2·5 mm. Though the slits are potentially completed so early, the two layers of hypoblast composing them are not separated from each other till the larvæ have attained twice this length. They are seen to be separating in a larva 4 mm. (fig. 137). The slits are not vertical, but extend downward and forward. In the early stages the thickened mass containing the rudiments of the gills are entirely lateral. Below there is but a single layer of mesoderm (139). After the potential slits have been formed the mesoderm between them grows downward and forward till it reaches nearly the median line in larvæ a little over 3 mm. long.

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tube extending from the posterior wall of the pericardium upward and forward; the yolk lies in the sinus venosus. About 22 protovertebræ are formed.

There is little change in general outlines for some time after a length of 1 mm. is reached. The tail elongates and fin folds are developed. One striking feature is that the fin-fold is very narrow at the tip of the tail, while the dorsal and caudal portion may be well developed.

The segmentation of the hind brain (fig. 93) becomes very prominent when the larva has reached a length of 2 mm. and remains so till the larva is 5 or more mm. long. During this period the hind brain (figs. 91, 93, 96) is divided by lines which are conspicuous during life, and quite evident in preserved specimens.

In larvæ 5 mm. long (figs. 94 and 95) the notochord extends to the tip of the tail, and a caudal fin-fold proper is not developed; the dorsal and anal folds are present. The posterior part of the anal fold shows a thickening where the caudal is finally formed. The pectoral has also made its appearance as a small flap on the shoulder. The liver has become well developed and fills a part of the space formerly occupied by the yolk, some of which still remains. The heart is still a simple tube without any differentiations. The intestine has become much enlarged, and in the protruding hind gut, which is distinctly differentiated, ridges have been formed on the inner side, which later become transformed to villi. The whole tube is still simple at this time without any loops.

The circulatory system (fig. 92) consists of an arch extending upward and forward from the heart, thence abruptly backward to beyond the middle of the tail, forward to near the anus, downward to the lower surface of the intestine, along which it extends till before reaching the yolk *it bends upward around the intestine* and then down over the yolk and into the heart. Shortly afterwards the intestine bends down at the vascular loop and forms the familiar sigmoid curve (figs. 96–100). By this means the portal vein runs straight forward along the ventral surface of the hind gut and then directly to the liver. The succeeding changes in the relative size and the curves of the various parts of the intestine may be gathered from figs. 93*a* to 93*e*.

Concomitant with the changes in the intestine the simple tube of the heart is transformed into auricle, ventricle, and bulbus arteriosus. While it is a simple tube it arises from the sinus venosus near the bottom. This origin is translocated upward till it arises from the top of the sinus. At the same time the tube has been lengthened and two constrictions have appeared. The posterior section comes to lie over the middle section; finally the upper is moved forward, and by the elongation of the bulbus the middle section is pushed backward so that the relation obtaining in figs. 96–99 results. The definite fins appear when the larva has reached a length of about 9 mm. (fig. 99). The further externally visible changes may be gathered from the accompanying figures (101–108). Pigment does not make its appearance till very late, and then only sparingly, except in the eye.

Formation of the intestine.—The fundament of the intestine can first be distinguished in my sections when three protovertebræ are formed and several others are outlined (figs. 67–74). The conditions are similar in a number of embryos sectioned, and I have selected for description one sectioned longitudinally and another transversely.

In a section in the sagittal plane (fig. 67) the line separating the chorda from the neural thickening is well marked. The line separating the chorda from the underlying hypoblast is quite distinct in the anterior part of the embryo where the chorda through the caudal mass (fig. 74) that the mesoderm can not be distinguished over the whole yolk.

The ectoderm forms a layer two to three cells deep over the whole egg. The outer layer of cells is in places well separated from the inner layers, the nuclei are slightly larger than those of the inner layers, and the cytoplasm stains lighter. The neural thickening consists of a solid ridge of cells extending down from the ectoderm to the notochord. From the sections it would appear that there is little difference between different points along this region. The ridge appears deeper just in front of the notochord than elsewhere, and here the lower layer of cells has a columnar arrangement.

The diameters of these embryos are respectively 0·27 mm. and 0·3 mm. The embryo has grown till it fills the shell and with but a slight further increase it hatches, the membrane bursting with the further expansion of the embryo. In other teleosts the hatching process is largely due to the muscular efforts of the embryo, while in this case the muscle cells can scarcely, if at all, be distinguished from other cells at the time of hatching. The yolk measures 158 μ to 200 μ.

I have not been able to secure stages between this and the embryo with six (?) or more protovertebræ, which is hatched.

General development of the larvæ.—At the time of hatching, the tail has not begun to bud out. The larva encircles the entire yolk and is so transparent that it can only be found with a lens. Groups of spermatozoa are found attached to its surface. No lumen has appeared in the intestine and muscles have not begun to be differentiated, so that the larva is entirely incapable of motion.

Shortly after hatching, the head and tail, exteriorly almost identical, sometimes overlap, the body being bent over the yolk (fig. 83). However, the larva rapidly straightens itself if this overlapping is normal at all. The lumen of the intestine appears when 10 protovertebræ have been formed (fig. 77) and Kupffer's vesicle has become enormously enlarged. The muscle cells have now become somewhat elongate, though motion is probably not yet possible. The tail is not yet free and the larvæ measure about 0·6 mm. By the time the larva has reached a length of 0·8 mm. the tail forms a thick blunt projection beyond the yolk and the intestine has a continuous lumen from near the anterior end of the notochord back to the future anus (figs. 78 and 84). The heart is represented by a large mass of cells below the head and about 12 protovertebræ have been formed. A swelling is evident in the gill region and shortly afterwards (by the time the larva is 0·9 mm. long) the first gill-slit is opened. The eye and auditory organs now become more prominent, but no otoliths are formed as yet. About 14 protovertebræ are present in larvæ 0·9 mm. long. Spermatozoa are now found in the intestine, which they reach through the first gill-slit.

If larvæ are examined from this stage till the mouth is formed a stream of the ovarian fluid is usually seen entering the gill-slit and escaping through the anus. This stream is kept in motion by very active cilia in the gullet.

When the larva has reached 1 mm. in length, the tail is formed to a considerable extent and terminates in a blunt lobe. The hypertrophy of the hind gut has begun and reaches some distance beyond the yolk-sack. One of the most peculiar structures of the larva, the enormous yolk-sack, has now become well developed. The yolk is quite minute and lies at the posterior end of this cavity, and all the remaining yolk-sack is utilized as a pericardium (figs. 88 and 90.) The heart is now a simple, slender

Some of the cells of the floor of the intestine may be derived from the roof directly. If so, such cells are derived from the region just below the chorda (fig. 127) and demonstrate the bilateral condition of the enteron. The same bilateral condition becomes still more evident later, when frequently two lumina make their appearance, especially in the anterior region (fig. 122). Kupffer's vesicle has now become much larger (figs. 75, 110, 113), but since it is such a striking feature of the stages succeeding the one under consideration it will be dealt with in a separate chapter.

In a slightly older larva (fig. 76), which differs from the one just described in being straightened out, the hypoblast presents in a sagittal section the same appearance seen in the preceding stage. But a layer of horizontal cells is now present between the yolk and the main mass of hypoblast (figs. 117, 125, 126, 127). In other words, the ingrowth of hypoblast has now reached the median line, and the floor of the enteron has been completed. Transverse sections demonstrate the completion of the floor in the whole of the postcephalic region exclusive of Kupffer's vesicle, which is now a very large cavity (fig. 76).

Soon after the completion of the floor as far as just described, the lumen appears both anteriorly and posteriorly (fig. 77). It is formed by the separation of the two layers of cells already formed. The separation usually begins laterally and grows towards the middle line. This is especially true of the cephalic portion (figs. 121, 122, 127, 130). In the front part of the body the hypoblast is about as high as wide (figs. 23, 130, 131), while in the posterior region it is many times as wide as high, encircling the whole of this portion of the yolk, and the lumen formed here is a Λ-shaped slit with very long arms, and occasionally an upward extension at the median line (figs. 124, 133, 134). The posterior lumen is, therefore, from the first potentially very wide, for as soon as the lower layer is separated from the upper to its full extent the intestine is relatively very large in this region.

As stated above, the lumen is formed in front and behind simultaneously. The *gullet or middle region remains a solid rod* (figs. 77, 131, 132). This appearance led me at first to suppose that the posterior intestine is precociously developed; but, as we have seen, the floor of the entire intestine is formed continuously from before backward, and the solid mass is the result of the retardation of the formation of the lumen between the two layers of the hypoblast, after such a separation has taken place in front and behind. I am not aware that a similar condition has been found in other teleosts more than once before. A similar condition is, however, described by Balfour (Elasmobranch Fishes, p. 217) for elasmobranchs. In elasmobranchs the œsophagus has a well-developed lumen like the remainder of the alimentary tract, but "its lumen becomes smaller and finally vanishes, and the original tube is replaced by a solid rod of uniform and somewhat polygonal cells." Although a lumen does not at first appear in *Cymatogaster*, its equivalent does, if we bear in mind that the floor is formed after the exact method used in elasmobranchs to form a lumen, *i. e.*, by the ingrowth below of the marginal cells of the hypoblast. What morphological significance this retrogressive development of the part of the intestine in elasmobranchs and in teleosts has I am unable to suspect, unless indeed Balfour's conjecture (II, 61) may be correct. He has found a solid œsophagus in the salmon (sp.) long after hatching. "It appears not impossible that this feature in the œsophagus may be connected with the fact that in the ancestors of the present types the œsophagus was perforated by gill-slits; and that in the process of embryonic abbreviation the cells have become very different from the hypoblast beneath and have become rearranged. In the caudal swelling the two structures are not separated by any distinct line, and the difference between the cells of the future chorda and the gut are not so well differentiated. In the head the hypoblast underlying the chorda is quite thin; caudad it becomes gradually thicker and finally columnar in arrangement. This columnar region stains darker than the surrounding cells. In the posterior part of this region the columnar hypoblast is raised from the yolk to form a distinct arch, or rather, as is seen in transverse section, a transverse fold raised from the yolk (fig. 73).

The outer edges of this fold are raised a little higher than the median portion, and it extends and gradually disappears backward. The floor of this arch is very largely formed by the yolk, its posterior extension entirely so. Below the arch there are a few cells which are very probably derived from its own roof, from which several cells project (figs. 68–73). This space is the first observed condition of Kupffer's vesicle. Cross-sections show that at this time the hypoblast extends over the greater part of the yolk, if not entirely over it (figs. 71–74; hypoblast cells have nucleoli indicated). Near the middle it is several (5) cells deep over nearly half the circumference of the yolk. It is columnar only below and a short distance on either side of the chorda; latterly it becomes thicker, but thins out again to a thickness of one cell (fig. 72). The section extending through Kupffer's vesicle shows that at its outer margins it extends as short pockets toward the ectoderm. In this fact it resembles very closely the conditions found later in the region of the forming gills, which arise as similar outward extensions from the alimentary tract.

In an embryo just freed from the zona radiata, and which still greatly resembles the stage just described, nine protovertebræ are formed, and the development of the intestine has made great progress. The anterior part of the chorda is well formed, and the hypoblast below it is but one cell deep. Caudad the thickness of the hypoblast increases till it is about five cells deep (fig. 75). In the anterior part, where the hypoblast is but one cell deep, evaginations extend upward and outward toward a point below the fundaments of the ear. These folds are of considerable cephalocaudad extension, reaching in one embryo through nineteen cross-sections (figs. 109, 115). These outpushings are for the most part solid at this stage. The peripheral cells of this structure (the gills) are columnar. The outer layer of cells extends some distance over the yolk. Immediately behind the gill region the method of the formation of the floor of the intestine becomes evident (fig. 110). The upper cells of the hypoblast have a dorsoventral columnar arrangement. The lower cells, on the other hand, have the longer axes of their nuclei in a horizontal position, the edges of the hypoblast having become turned in. No space is at first evident between this lower and the upper layers, the infolding resulting in a solid bilateral mass of cells. The lateral extent of the hypoblast is no longer as great as it was in the preceding stage (figs. 110–112). Farther back, where the ingrowth to form the potential floor of the intestine does not take place until some time later, and where the intestine, as will be seen later, is very wide from the beginning, the hypoblast still extends over a considerable portion of the yolk (figs. 112, 113). The same process of forming the intestine takes place in this region later, *i. e.*, the hypoblast becomes columnar and cells grow from the margin inward to form a layer between the yolk and the main mass of hypoblast cells without at once forming a lumen.

come in contact with them they are whirled about so that the presence of cilia becomes very evident. In later stages they become conspicuous in sections and smaller cilia seem also to be formed in the wider parts of the intestine, but I have not been able to demonstrate them in sections.

Cilia have recently been described in the intestine of fishes by McIntosh and Prince, 1891, p. 772: "Many preparations show a lining apparently of cilia, and there is thus great probability that the enteric tract—the œsophageal portion at least—of young teleosteans is ciliated."

The intestine is now a single tube from the hyobranchial slit to the anus, with four well-defined regions: the gill-cavity into which the gill-slit opens, the ciliated gullet, a narrow indifferent region (the future stomach), and the wide hind gut with high columnar cells. So far none of the glands to be derived from the enteron have appeared. The liver and air-bladder appear in the stages immediately succeeding the one described in the third region enumerated. The hypophysis and the thyroid gland are derived still later from the lining of the buccal cavity and the hypoblast extending forward from this region.

Before describing the further development of the alimentary tract it will be necessary to go back and follow the modifications of Kupffer's vesicle which, at the last stage described, has disappeared.

Historical on alimentary canal.—Hoffmann, 1882, p. 5, found the hypoblast to consist of a single layer of spindle-shaped cells whose lateral extent was not equal to that of the mesoderm. He found the tube to be formed from in front backward. In the head region the hypoblast has a great lateral extent, and it is here that two lateral infoldings occur. The second or lower layers so formed grow toward each other till they meet. The two layers lie close upon each other, so that a lumen is not evident from the first. The gills are formed by a still further outgrowth in definite regions and are developed from in front backward. He considers the formation in the region of the ear-capsule peculiar, since the hypoblast which is here folded first of all extends *upward* so that it lies close to the auditory vesicle. These outpushings move forward later when the gill formation has begun and finally break through to the outside and form a larval spiracle. It soon disappears. In the trunk the intestine is formed by two infoldings, as in the head, but the hypoblast is much more restricted laterally and the intestine consequently much narrower. A lumen does not appear at once, and this is formed in the hind gut first.

Agassiz and Whitman, 1884, found the secondary entoderm one cell deep. This is divided into two masses by the chorda, but the two parts unite below the chorda later. About the time the blastopore closes the strip beneath the chorda becomes two or three cells deep. This thickened mass gives rise to the alimentary canal, but how the tube is formed they were unable to say.

Henneguy, 1884, found in the trout (*Salmo fario*) that at the time of the differentiation of the secondary entoderm it is composed of one or two layers of cells. (Later, p. 122, he says three or four.) During a stage with from 12 to 18 protovertebræ, when Kupffer's vesicle is well formed, the entoderm begins to become infolded below the anterior end of the notochord to form the intestine. The entoderm at this time extends forward to in front of the auditory vesicle. It is raised on each side of a median line, below the auditory vesicle, and it is here that the first infolding becomes evident. The infolding at this time does not extend beyond the anterior third of the embryo. The lumen in this region appears when the embryo is 3·2 mm. long and has about 22 somites. In the formation of the gill the hypoblast extends out to the epiblast without any invagination of the latter. The intestine in the anterior portion is formed as I have described it for *Cymatogaster*. Towards the middle the intestine is said to be formed in a different manner, the hypoblast being raised in the middle line to form a canal bounded below by the periblast.

McIntosh and Prince find that in the embryo whose optic vesicles are in process of formation the hypoblast is a thin sheet over the entire ventral surface save at the posterior extremity. Later it becomes a massive cylinder and the oral tract a wide flattened sheet of hypoblast, the pharynx being a separate and later formation than the mesenteron proper. They consider Kupffer's vesicle as the first indication of the alimentary tube, and it is only in this region that the alimentary tract is ever open to the yolk below. The hypoblast reaches as far as the cardiac region, where it thins out. With the thickening of the hypoblast the embryo is raised from the yolk. Beneath the eyes the hypoblast becomes thickened as two longitudinal ridges. The ventral wall is formed by hypoblast cells pushed in from the side, or of periblast cells. They seem to think that the periblast contributes in some degree to build up the entire mesenteron. The mid and fore portions are said to form a dense cord, in which a lumen appears later by a forward extension of the posterior enteric chamber. In other words, the lumen is formed from behind forward, the mouth and anus being the last parts formed. The œsophageal portion they found ciliated in later stages. On the thirteenth day the alimentary tract of the gurnard is differentiated into the following regions: (1) Oral chamber large, but depressed. (2) A wide œsophagus, the lumen of which is a horizontal fissure; from this part the pneumatic duct is given off. (3) An enlarged stomach with the hepatic mass below. (4) A pyloric portion into which the ductus choledochus passes. (5) The intestine.

Wilson, 1890, found that the alimentary canal was formed "by a process of folding, essentially akin to that found in amniota. After the formation of the notochord the entoderm is one cell thick, the cells being uniform. In the trunk region the cells become thicker and a fold rises up at this point, the two sides being separated by a slight slit. In the anterior region there is a fold on each side which grows up and forms the embryonic gill-slits. In the posterior part of the trunk the entoderm becomes thickened along the median line" but is not raised up in a fold; this region is transformed into the postanal gut.

Kupffer's vesicle.—Kupffer's vesicle, as has been hinted in the preceding pages, has a remarkable history in *Cymatogaster*. It arises as an up-pushing of the hypoblast which has previously become columnar, in the posterior part of the embryo when about three protovertebræ have been formed (figs. 67, 68, 70, 73). It later develops a floor of hypoblast as usual among fishes. But here comparison must stop. While in teleosts in general it is quite a minute structure* and entirely disappears behind the region of the anus in some teleosts, in *Cymatogaster* it becomes frequently half the length of the yolk into which it pushes or eats a large pit and finally is divided into three distinct vesicles, each one of which is larger than the ordinary Kupffer's vesicle, and each of which has a different history and fate. The middle one remains as an enlargement

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*In *Ctenolabrus* it measures 0·03 mm. during its largest stage. In *Cymatogaster* it reaches a length of 0·13 mm., which is about half the length of the yolk. Its maximum height, exclusive of the depression formed in the yolk, is about 0·05 mm.

of the hind gut, which, however extends even further in later stages, the anus forming some distance behind the original place of the vesicle. The lower one remains for some time as a space in the yolk and the upper one is pushed upward and disappears through a proliferation of the cells of its wall when about fifteen protovertebræ have been formed. I will describe the successive phases of this structure as they could be made out by my material. The conditions described by Henneguy for the trout approach nearer those of the middle vesicle of *Cymatogaster* than any others made known so far.

As stated above, Kupffer's vesicle makes its appearance early; when three protovertebræ have been formed it is a well-defined structure. Before this stage it has not been seen. At this time it is a broad, short, low space between the yolk and the hypoblast, a short distance behind the end of the notochord. The hypoblast cells forming its roof are high columnar. The greater part of the floor is composed of the yolk, but in a few places cells are also found on the floor of the vesicle, but these are not regularly arranged. (Longitudinal sections 67, 68, 70; cross-section, fig. 73.) The columnar arrangement of the hypoblast cells is continued forward for some distance in front of the vesicle. The antero-posterior extent of the vesicle is much less than its lateral extent. The outer angles of the vesicle are pushed slightly upward and outward, giving the roof an angular appearance and greatly resembling the conditions of the gills in slightly older larvæ. For these reasons I at first considered this stage of Kupffer's vesicle as the first indication of the lumen of the alimentary canal in the region of the gills.

In a larva with ten protovertebræ it has become a large shallow subcircular cavity in the entoderm and is still floored by the yolk. From its roof a small dome-shaped cavity extends still deeper into the indifferent or hypoblastic mass of cells forming this part of the larva. The contour of the yolk is not affected by the vesicle (fig. 75). The cells in the tail of this larva are somewhat disarranged, so that the relations of the vesicle with the surrounding structure can not be definitely made out. It is, however, only in this region that the entoderm and yolk are not in close contact. The lumen of the intestine has nowhere appeared as yet.

The larva at this time forms an almost complete circle around the yolk. As the larva is straightened out and the lumen of the intestine is formed, and even before any lumen appears (fig. 76), Kupffer's vesicle enlarges rapidly. The arrangement of the entoderm cells in front of the vesicle shows that it is from the first an enlarged portion of the alimentary tract, which remains without a floor long after a floor is formed in all other parts. At this time the vesicles differ greatly in shape in different specimens, but all the larvæ examined show the following structure:

First. A low cavity in the entoderm with considerable lateral extent. Its dorsal wall of columnar hypoblast is a direct continuation of the roof of the alimentary tract.

Second. A dome-shaped cavity usually in the anterior half of the vesicle extending dorsad (figs. 76, 77, 144). This dome-shaped portion, which was evident in the earlier stage, forms, as will be seen later, the lower half of the neurenteric canal.

Up to this stage the vesicle is formed exclusively at the expense of the entoderm which surrounds it above and on the sides, and frequently forms a floor at the margin of the vesicle. The contour of the yolk has not been affected. Over the center of the dome the cells are usually somewhat irregularly placed as compared with those of its sides, but a neurenteric canal I have not been able to find in this stage.

With the further growth of the vesicle the yolk is usually infringed upon (fig. 145). Whether this is accomplished by the absorption of a part of the yolk, or whether it is simply crowded down, I am not able to say. I am inclined to believe that it is pushed down by the contents of the vesicle; otherwise the rearrangement of the yolk particles would soon fill up the gap made by absorption. However, in later stages of yolk absorption (fig. 136) the yolk is frequently eaten into in very much the same way without any apparent rearrangement of its parts.

After the vesicle has reached its largest size it acquires a cellular floor which corresponds with the *original* outline of the yolk (fig. 146). The vesicle is thus cut in two, a larger yolk vesicle and an upper vesicle which forms the enlarged portion of the hind end of the intestine. The cellular floor seems to be formed by an ingrowth from all sides. Both sagittal and transverse sections show that in earlier stages hypoblast cells extend in below the margin of the vesicle. These would simply have to extend still further centripetally to form a floor for the whole vesicle. The depression in the yolk is at the same time converted into a spherical vesicle, which may be termed the yolk vesicle. It is sometimes partially filled with a brightly staining substance, and as it is quite evident in entire specimens (figs. 84 to 86) I supposed it to be the yolk nucleus before I examined sections and learned the fate of that structure. In one larva the yolk vesicle was found at the ventral side of the yolk (fig. 85). The yolk vesicle remains longer than Kupffer's vesicle, and in fact the intestine extends some distance beyond it before it disappears. There seems to be no regularity in its disappearance, and probably no importance attaches to it after it is separated from the main vesicle.

The cellular floor of the vesicle rapidly thickens as the tail begins to grow out, while its communication with the alimentary canal is maintained (fig. 147). The dome-shaped part is probably constricted off at this time (12 protovertebræ), and the remainder of the vesicle is reduced to the caliber of the rest of the alimentary tract. My sections tell conflicting stories about the exact processes. Figure 78 shows an irregular cavity at the end of the mesenteron, which I consider the remains of the main vesicle. This cavity is connected by an area of disconnected cells with a vesicle lying dorsad of it. Figure 148, on the other hand, in which the tail is not as long as in figure 78, shows a dilation of the intestine dorsad, at the end of which lies a triangular cavity. It would appear that a part of the body of the original vesicle had been constricted off with the dome. The same appears to be true of figure 149. In both these larvæ the cells below this cavity are disarranged. The connection of this dorsal cavity, or vesicle, with the alimentary canal is now represented by the disarranged cells only. The two different structures, vesicle and disarranged cells, may, however, be harmonized. The dorsal vesicle disappears by the proliferation of cells from its wall into its cavity. These cells would at first be expected to be arranged somewhat differently from those in the older structure. In figure 78, which represents the older condition, the process has gone far enough to obliterate all of the body of the vesicle which had remained with the dome.

Neurenteric canal.—Several of the larvæ described above leave no doubt as to the meaning of the dome-shaped structure of Kupffer's vesicle. It is part of the neurenteric canal. In all late stages, as in figure 148, there are fewer cells above the neurenteric canal than in neighboring regions, and in several cases a tubular connection undoubtedly exists between the remains of the dorsal vesicle and the neural region.

In three cases (78, 148, 149) the dorsal portion is wholly or partly filled with cells. This is especially well seen in fig. 78, where the boundaries of the dorsal half of the canal are as well marked as those of the ventral half, but in which the dorsal half contains cells. The same is true of another larva (fig. 148), but in this instance the walls of the dorsal half are not so well defined. In another larva (fig. 149) a narrow but well-defined canal extends from the remains of the vesicle upward and then curves forward. This is probably only the posterior wall of the neurenteric canal. More or less well-defined lines extend from the anterior portion of the dome upward. The same condition can be traced in series of transverse sections. There seems then to be but little room for doubt about this structure. All the evidence indicates that in part at least it is the neurenteric canal.*

Kupffer's vesicle in general.—Kupffer's vesicle is evidently a rudimentary structure, without function in the majority of fishes. Several quite distinct views have been held as to the significance of this structure.

Kupffer, who first described it, and recently Henneguy, considered it to be the allantois of higher vertebrates.

Balfour homologized it with the postanal vesicle of elasmobranchs.

Cunningham, Ziegler, McIntosh and Prince, consider it to represent the invaginated gastrula (archenteron) of cyclostomes and plagiostomes.

Kowalewski holds in the main to the same opinion.

Henneguy formerly considered it the homologue of the primitive intestine of cyclostomes and amphibians. Many others who have seen the structure are noncommittal as to its significance.

The variety of opinions may in part be due to the variation of this structure in different fishes, for there is no doubt about the variability of the vesicle. It is difficult to see how a waning structure can represent a condition that has not appeared before phylogenetically and does not appear till in much higher vertebrates. I can not see how it can represent the allantois. Cunningham's theory is based on the presence of a canal between the vesicle and the blastopore. This canal is certainly not present in *Cymatogaster*, where the vesicle does not appear till long after the blastopore is closed.

Wilson considers the early stages homologous with the terminal part of the archenteron of amphibians and the later stages homologous with the postanal vesicle of elasmobranchs.

The fact that in the majority of fishes it arises long before the alimentary canal and disappears, or at least diminishes, before the alimentary canal is formed argues against its homology with the postanal vesicle of elasmobranchs. It must be conceded, however, that in fishes the alimentary canal is late in making its appearance as compared with elasmobranchs. The alimentary tract is retarded in teleosts for some reason or other. The caudal vesicle is functionless in elasmobranchs and the

causes which brought about a retardation of the functional intestine would not necessarily affect the functionless postanal section. It thus happens that the postanal vesicle in teleosts appears as Kupffer's vesicle before any lumen is formed in the intestine. In *Serranus*, at least, it lies at the end of a postanal gut. In the trout, according to Henneguy, and in *Cymatogaster* it is at least in part incorporated in the intestine. Kupffer's vesicle is, moreover, the only part of the intestine raised from the yolk before a floor is acquired. [In *Serranus* (Wilson, 1890) this raised portion is not confined to Kupffer's vesicle.] Kupffer's vesicle, in *Cymatogaster* at least, is more than the postanal vesicle of elasmobranchs. The archenteron, the postanal vesicle, and neurenteric canal all seem represented by it.

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* I want to point out here the possibility that the neurenteric vesicle alone represents the caudal vesicle of other teleosts, and that its connection with the lower part of the vesicle which is converted into the hind gut is after all due to the precocious development of the hind gut, which thus extends past the region of the original Kupffer's vesicle before the growth of the tail has carried the latter farther back. In that case the postanal gut would be represented by the dorsal wall of the hind gut; *i. e.*, the region between the hind gut and the neurenteric vesicle. This would account for the fact that I have not been able to find any other structure which might be homologized with the postanal gut frequently described for teleosts. The lower or main part of the vesicle may then be looked upon as the archenteric cavity.

In *Cymatogaster* it is seen that a part of this vesicle is for a time the direct continuation of the alimentary tube and that during this time a narrow slit (neurenteric canal) extends upward from its anterior half. This upward extension is formed in *Ctenolabrus*, according to Agassiz and Whitman, at the closing of the blastopore. But the condition described by them I have never been able to see in any of the pelagic eggs examined by me.

If we consider a part of the vesicle the homologue of the postanal vesicle of elasmobranchs it remains to be shown why in *Cymatogaster* it forms part of the permanent intestine. The cause is not far to seek. The embryo, in the first place, is shortened on account of the small yolk at the periphery of which it is formed, the tail being represented by a large knob of undifferentiated cells. On the other hand, the alimentary canal is precociously developed, owing to viviparity, and the whole of the hypoblastic area is utilized in forming the permanent alimentary tract.

Agassiz and Whitman (1884) traced Kupffer's vesicle in several species of pelagic eggs. In the formation they found what Kingsley and Conn had already well described. It "arises by the fusion or confluence of a cluster of granules. * * * In *Ctenolabrus* the granules appear soon after the embryonic ring passes the equator, when the length of the embryo is about four-fifths of the diameter of the ovum. Its maximum diameter when fully formed is seldom more than 0·03 mm. During its formation, till it reaches its maximum size, it lies beneath the chorda and the entodermic stratum and has no sort of relation with any tubular structure whatever. * * Ventrally and laterally it is bounded by periblast material. * * * It grows smaller after the closure of the blastopore, and during this period in a number of species it rises from the periblast into the entoderm, where it vanishes." Behind this they have found a variable number of secondary caudal vesicles.

Henneguy (1889) describes some of the distinguishing phases of Kupffer's vesicle in the trout (*Salmo fario.*) (He first described it as early as 1880.) The first indications of a modification in the region of the future vesicle were noticed very early and the vesicle itself was quite large when but two or three protovertebræ had been formed. The cells in this region are larger than the others and are undergoing division. There are but few of these cylindrical cells, and they are in contact with the periblast, and later one sees "une invagination se produise dans l'embryon pour former la vésicule." This mass of cells is the first indication of Kupffer's vesicle. Its growth must be quite rapid, for it is 0·11 mm. long and 0·09 wide when but two or three protovertebræ are formed, and occupies "la place de la corde dorsale," *i. e.*, it is entirely surrounded by hypoblast. It lies just in front of the caudal swelling "au point où commence à se differencier le mésoderm." He points out that it differs in its position in the entoderm

from the condition usually prevailing in fishes where it projects into the vitellus. He then states that this difference is of no importance (1881), for in a later stage the vesicle "peut faire saillie hors de l'embryon" and thus become as in other fishes. In other words, the process described by Agassiz and Whitman is here said to be inverted. In a stage with twenty-two protovertebræ it is figured as the enlarged posterior end of the alimentary canal. It would here, then, permanently form a part of the intestine, and in this respect agree with the middle vesicle in *Cymatogaster*. It elongates antero-posteriorly and becomes pyriform. It comes directly in contact with the nervous thickening above. It is only the first indication of the digestive tube. It is important on account of its relation with the nervous system and the notochord and the region corresponds to the region of the neurenteric canal of other vertebrates. He has never found a canal leading to the exterior. He considers the opinion of Kingsley and Conn, Agassiz and Whitman, Cunningham, Ziegler, that the vesicle lies between the periblast and the hypoblast, to be based on an error of observation.

Frequently there exists below the vesicle or in its neighborhood a hemispherical depression in the surface of the vitellus. (It is possible that in this case the vesicle divides into two, a yolk vesicle and the intestinal vesicle seen in *Cymatogaster*.) He thinks the original opinion of Kupffer may still be defended when one considers that it is the first indication of the alimentary canal in the neurenteric region and that the allantois of higher vertebrates is but a diverticulum of the intestine appearing very early in front of the neurenteric canal.

In *Serranus*, according to Wilson, the vesicle appears as an up-pushing of the hypoblast, which had previously become columnar, and a down-pushing of the periblast. It disappears by the proliferation of cells from its own walls. It is formed some distance behind the future anus and lies in the postanal gut. In this respect it greatly resembles the postanal vesicle of elasmobranchs, with which it is homologous. "Before Kupffer's vesicle is folded off it represents the terminal dilatation of the archenteron itself, and in this phase is to be compared with the dilated posterior extremity of the archenteron in certain amphibian gastrulas."

McIntosh and Prince (1890) observed the vesicle in a number of species. They find that it arises, as Kingsley and Conn have described, by the union of a number of granules or small vesicles. They found secondary vesicles quite frequently, sometimes extending "all along the ventral line almost to the pectoral region." Its contents are usually homogeneous and clear, though granules are occasionally present. They claim to have traced a neurenteric canal from the vesicle to the blastopore at the time the latter closes.

Formation of liver and air bladder, mouth, thyroid gland, and hypophysis.—In a preceding chapter the intestine was described from its first appearance until, in larvæ 1 mm. long, it forms a simple tube from the hyobranchial gill-slit to the anus. In the stages succeeding that the rudiments of the liver and of the air-bladder make their appearance. Parts of the tract are at the same time otherwise modified.

In larvæ 1·8 mm. long (figs. 150, 156, 157) the intestine is broad and depressed just behind the hyobranchial slit, and its walls are composed of ciliated cells 18μ high. In the roof the nuclei of the cells are slightly nearer the free ends of the cells and nearly all are on the same level.

In the floor there are besides this layer of cells a few scattered ones among the bases of the others (figs. 156, 157). Towards the back part of the gullet the lumen

migrated in through the gill-slit. In the ciliated gullet the cells are 22μ high. On the roof this tract extends farther caudad than on the floor, where it does not extend beyond the gill thickenings. The walls of the mid gut are again of a low epithelial nature, while the cells lining the hind gut are of quite another nature. They are high and the small nucleus is situated near the base of the cells, where the contents are slightly granular. The center of the cells is a large unstainable space very variable in size. The free ends of the cells are again granular. Some of these cells contain deeply stained bodies similar to those found in the lumen, and it seems very probable that these bodies have been swallowed by the cell and are in process of reduction by intracellular digestion. At the anus the epithelium of the roof of the intestine is continuous with that of the floor of the combined segmental ducts. The cells of the floor of the intestine are continuous with those of the ventral surface. The segmental duct empties just behind the anus and not into a cloaca or into the intestine.

In an earlier stage it was noticed that the mouth was first indicated just behind the eye. The conditions obtaining in larvæ of this stage are shown in figs. 167 to 171 (3·2 mm.); the mouth is essentially like the other gills, especially the spiracular, and agrees in all major points with the condition described by Dohrn. That is, the mouth is further developed laterally than medially and some distance behind the point where it attains its full development. In the larvæ 1 mm. long I was unable to trace the hypoblast cells much beyond the notochord. In other words the alimentary tract begins in the hyobranchial region in those larvæ. It soon extends forward in the median line and, as far as I could determine, the outgrowth of hypoblast to form the hyomandibular slit takes place later than that to form the hyobranchial. In larvæ 1·8 mm. long the hypoblast extends outward to the ectoderm just behind the eye. This I have identified as the first indication of the future mouth (figs. 154, 181). In these larvæ the hypoblast does not yet extend to the anterior end, and the mouth is a strictly bilateral structure. The hyomandibular evagination is separated from the mouth evagination by a more restricted region of hypoblast (fig. 153). This evagination does not differ materially from the mouth evagination. In each case the ectoderm is two layers thick where the hypoblast touches it. But one of the gill evaginations has been completed and the second is in process of formation (figs. 150 and 151). The details of the completion of the mouth have not been traced. It is not functional when the larvæ are 4 mm. long and in fact the lumen does not extend forward any farther than in the 3 mm. larvæ.

The mouth is completed shortly after the larvæ have reached 4 mm. This lateness of the appearance of the mouth seems to me to be one of the most remarkable circumstances connected with the development of the alimentary tract. Thus while the intestine becomes functional when the larvæ have reached a length of 1 mm. the mouth is not formed till they are over 4 mm. long—not in fact till the liver has long been functional, the air-bladder well developed—not till all the glands derived from the hypoblast are well developed. Not only is the mouth late in appearing but the whole canal from the gill-cavity forward is also late in forming. While this may be due to retardation, since ingress to the canal is had through the first gill-cleft, the conditions impress one with the suggestion of Dohrn that the present mouth of vertebrates is not the original mouth, but is of comparatively late origin. How one structure may replace another as a mouth is well illustrated by *Cymatogaster*, where a new structure, the hyobranchial gill-cleft, functions as a mouth for a long time. It would

becomes narrower and higher, and the cells at the same time lose their great height and their cilia; just behind the gill swelling the lumen is subcircular or horizontally oval. Its walls are composed of a single layer of cells but 5μ high. Still farther back the lumen becomes vertically oval, and the cells of the floor lose their columnar nature and multiply so that a thickened floor is formed. The change in shape of the lumen (159 and 160) is due to a longitudinal groove, shallow in front, becoming deeper behind, abruptly stopping still farther back just in front of the hind gut. Behind this place the lumen is again contracted. This ventral groove and thickening of the floor is the rudiment of the liver. The region through which this groove extends is quite extensive, reaching through 19 sections of the 85, making up the entire length of the intestine, or through almost the entire region from the ciliated gullet to the hind gut (fig. 162). A short distance behind the pronephros another thickening appears in the walls of the intestine, this time in the roof, which is at the same time extended laterally (fig. 160). This upper thickening is not so extensive, reaching through 10 sections and extending in the early condition as far back as the lower mass. This upper thickening is the rudiment of the air bladder. The mesoderm surrounding the alimentary tract in these regions is also considerably thicker than in other regions. At the beginning of the ventral groove the lumen of the intestine has a diameter of 45μ, the cells a height of 9μ. At the end of the groove the lumen has a diameter of 68μ, and the cells lining it have a height of 13μ. Just behind the groove the height of the lumen is again reduced to 45μ. From this point the intestine rapidly widens till it reaches a diameter of 160μ (fig. 161). The cells lining this portion are 22μ high. Just in front of the anus the lumen becomes a vertical slit and the inner layer of the ectoderm becomes reinforced along the ventral line to form a keel. For four sections the anus is a vertical slit, the sides of which flare outward below. Behind the slit it is continued as a median groove with equally flaring sides, on the crests of which the nephridial ducts empty. On either side of the vertical portion of the intestine, just in front of the anus, the splanchnic and the somatic mesoblast are united in a solid mass in which the sex cells are embedded. Behind the anus a short, solid cord of hypoblast extends into the tail, between the aorta and the caudal vein. In older larvæ the ridges behind the anus meet in the median line and the segmental ducts thus come to empty in the median line. The relations of the liver to the air-bladder in older larvæ may be gathered from figs. 162 and 163. Their further development in a larva 2·5 mm. long is shown in fig. 165, where the gall-bladder has begun to develop.

In larvæ a little over 3 mm. long, the thyroid gland and the hypophysis are well along in their development. These larvæ measured 3·2 mm. after hardening, and were probably longer in life. The intestine (figs. 166 to 174) has not changed much except in the regions of the gills. The lumen extends forward to in front of the thyroid gland. Anterior to this point the two layers of hypoblast cells are still in contact with each other. The mouth has, however, become evident laterally, as will be seen from fig. 169. The anterior opening of the intestine is still the hyobranchial gill-slit. The ciliated gullet has now reached its full development. In the entire gill region the intestine is depressed; its width decreases in this region from 181μ to 112. Behind the gullet it dwindles to a diameter of but 22μ; in the hind gut it reaches 136. In the anterior gill region the walls of the enteron are less than 4μ thick and consist of a layer of pavement cells unquestionably of hypoblast origin and of a layer of very thin cells (fig. 172). This thinner layer I take to be ectodermal cells

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need but continued conditions, such as exist in the ovary for the hyobranchial cleft, to entirely replace the present mouth. To discover where the primitive mouth was is quite another question. We may assume that it opened into the gill-cavity in the region of the first gill-slit, since here a lumen exists long before it is formed forward. In this connection a strand of hypoblast cells extending up from the wall of the intestine in the median line just in front of the chorda becomes of great interest. It is indicated quite early (fig. 152), or as soon as the lumen is continuous from the gill-slit to the anus, and it is still striking in larvæ over 3 mm. long (fig. 166), after which it gradually disappears. This structure is not connected with the gills nor have I been able to connect it with the history of any other structure. This strand of hypoblast cells may indeed be the vestige of the primitive gullet. I have so far not been able to trace it through or even into the brain.

The thyroid gland and the hypophysis make their appearance when the larvæ are about 1·8 mm. long. The thyroid appears as a thickening in the ventral layer of hypoblast just in front of the anterior end of the heart (figs. 171*b* and 171*c*). The hypophysis is somewhat different from the start. The cells of the roof become columnar and several layers thick and a refold is formed. This condition is well demonstrated in fig. 166.

Shortly afterward the infolded cells are constricted off from the rest of the hypoblast and lie as an independent structure at the base of the brain (fig. 177).

Gills.—The formation of the first gill-slit has been described in connection with the intestine, and the hyomandibular and mandibular slits have also been considered. It remains now to trace the formation of the posterior slits. Soon after the formation of the hyobranchial a thickened mass is formed behind it; this mass extends out beyond the outline of the body of the embryo, and owing to its well-defined limits is conspicuous in the living larva (figs. 83–91) as well as in sections. (Figs. 137, 139, 150–157, 172 to 174.)

This mass is largely composed of mesoblastic cells. It grows very rapidly and from it are derived the skeleton and the soft parts of the gill-arches. The gill-clefts arise as pouches extending out from the entoderm. These may be met by shallow ingrowths of ectoderm (fig. 150, *br.* 8). The pouches are formed from the hyobranchial backward. They seem to be somewhat irregular at first and hollow (figs. 151 and 156), but later the layers of hypoblast forming them are closely appressed, all the space between them having disappeared. The second is forming when the larva is about 1 mm. long (figs. 136 and 137); the third when it has reached a length of 1·8 mm. These measurements are after hardening; the living larvæ were probably somewhat longer.

The fifth slit is nearly completed at 2·5 mm. Though the slits are potentially completed so early, the two layers of hypoblast composing them are not separated from each other till the larvæ have attained twice this length. They are seen to be separating in a larva 4 mm. (fig. 137). The slits are not vertical, but extend downward and forward. In the early stages the thickened mass containing the rudiments of the gills are entirely lateral. Below there is but a single layer of mesoderm (139). After the potential slits have been formed the mesoderm between them grows downward and forward till it reaches nearly the median line in larvæ a little over 3 mm. long.

SUMMARY OF CONCLUSIONS.

1. Copulation takes place in June or early July. This statement is based on the fact that the testes of the male are very much enlarged at this time and on the fact that the ovaries from now on are filled with spermatozoa. The act of copulation has not been observed.

2. The secondary sexual differences are considerable—among them may be mentioned a small gland or bag on either side of the anal of the male. From it extends a papilla forward to beyond the anterior margin of the fin.

3. The spermatozoa have a long rod-shaped head in place of the globular one usual in fishes.

4. The spermatozoa remain dormant in the ovary till December, when they become exceedingly active.

5. The eggs mature and are fertilized between November 1 and February 1, the largest fishes maturing the eggs earliest, the next in size a little later, and the smallest individuals last.

6. Those spermatozoa not utilized in fertilization remain in the ovary for several weeks longer. They are finally eaten by the larvæ when the digestive tract of the latter has been sufficiently developed.

7. During the early stages of gestation the females remain in shallow water; males are then rarely seen. Later they become scarce, but near the time the young are freed and shortly afterwards they are again found in shallow water.

8. The largest ovarian eggs measure about 0·3 mm. in diameter. During the process of maturation the egg contents shrink to a diameter of 0·2 mm., or to less than one-third of its maximum size.

9. The egg of this fish (*Cymatogaster aggregatus*) is 130 times smaller than the normal fish egg, which has an average diameter of 1 mm.

10. This small size is largely if not entirely due to the nonformation of deutoplasm.

11. The egg is fertilized while still in the follicle. Some sections show the extrusion of the second polar globule and the presence of the male pronucleus in an egg still surrounded by the cells of the follicle. The latter have begun to degenerate.

12. The development begins after the egg has been freed from the follicle. Eggs with 1, 2, 4, 8, and 16 cells, as well as many later stages, were found free in the ovary.

13. Neither the developing eggs nor the young are in later stages at any time connected with the parent, nor is the position of these in relation to the ovarian structures a fixed one.

14. The duration of gestation is probably five months and the number of young from 3 to 20, according to the size of the parent. In less than a year after birth the young are gravid.

15. The food of the young is supplied by the epithelium of the ovary. The cells enlarge and become clear, when they collapse, their contents are emptied into the lumen of the ovary, and the framework of the cells soon follows. When the intestine begins its work the spermatozoa serve as part of the food. The ovary at no time was observed to contain more fluids than the peritoneal cavity. (In other species considerable fluid is sometimes present.) Before the development of the alimentary tract the ovarian fluid is probably appropriated by a process of intracellular digestion on the part of the epidermal cells.

16. The yolk is a waning structure and can scarcely be taken into consideration in accounting for the growth of early stages.

17. During the whole of gestation respiration is carried on by the osmotic action between the general surface and the closely applied ovarian structures. When the alimentary tract is opened a current is kept flowing through it and aëration is, in all probability, effected by the alimentary tract. In later stages the fins become highly vascular and doubtless serve both for purposes of aëration and food absorption.

18. There is present in the entodermic pole of the developing egg a body the like of which has not been observed in any other egg. It consists of a mass of protoplasm imbedded in the yolk. It is dissolved near the time of the closing of the blastopore. Mr. J. W. Hubbard, one of my students, has connected its history with that of the yolk nucleus, which is a conspicuous structure in the ovaries of adult fishes in eggs from 20 μ up to maturity. It is a general extrusion from the nucleus of the young ovum, and probably represents the histogenetic or somatic portion of the nucleus, and this in part at least corresponds to the macronucleus of ciliate infusoria.

19. Before segmentation begins the whole of the germ is separated from the deutoplasm. The first cleavage plane extends entirely through the germ to the yolk before the second cleavage begins.

20. A segmentation cavity is not formed during segmentation, but appears later by a separation of the ectoderm and entoderm.

21. The third cleavage plane is not parallel with the first, as is usual in fishes, but is semiequatorial. This has nothing to do with the horizontal cleavage claimed to have been seen by Hoffmann and by Brook. It is taken to be a pseudoreversion to primitive methods of segmentation, with the reservation that this condition is not perfectly homologous with the third segmentation of the frog or *Branchiostoma* and would not be, had the yolk entirely disappeared.

22. The periblast is formed from a few of the marginal cells. Like the yolk it is a waning structure. Only about 12 cells are ever formed. They take no part whatever in the formation of the embryo. All of them persist as long as a trace of the yolk is left. It, with the final part of the yolk, is absorbed by the blood of the sinus venosus. The liver has nothing to do with its final absorption, as Wilson has claimed, but simply mechanically incloses the nuclei above and behind.

23. During an early stage of segmentation some of the marginal cells of the blastoderm creep over the yolk till they nearly, if not entirely, cover it.

24. Before gastrulation the yolk sinks into the mass of the blastoderm, the cells of which rearrange themselves about it and nearly inclose it.

25. The gastrula is finally formed by a process of delamination of entoderm from ectoderm and is completely diplastic and symmetrical, the blastopore closing at the entodermic pole of the egg.

26. Before any other organs become evident the sex cells become conspicuous. Their fate I have discussed elsewhere.

27. The earliest stages of the formation of the embryo have not been clearly made out with the material at hand. It is, however, certain that in one of the figures published by me in the "Journal of Morphology," I mistook the tail for the head. The conditions are extremely similar to those found in the mammalian embryos, except that the central cavity is filled with yolk instead of fluid.

28. The mesoderm is formed by a process of delamination from the entoderm. It is formed as two sheets and over the whole of the entoderm exclusive of the axial line.

29. The young fish is freed from its membrane in a very immature condition. It completely encircles the yolk; in fact the head and the tail overlap. It is incapable of motion at this time and indeed the cells which will form the muscles have scarcely become differentiated. The hatching process is due to the growth of the embryo and not to its activity, as is usually the case. The fin-folds do not appear till much later.

30. Kupffer's vesicle appears very early and is very large. It consists when fully formed of a dome-shaped roof over a large cavity surrounded on the sides by entoderm. It at first rests on the yolk, but soon the yolk is forced down and presents a deep impression just beneath the vesicle. Later the vesicle is divided into three distinct cavities. The upper dome-shaped portion persists for some time and probably represents parts of the neurenteric canal. The middle portion remains for some time as an enlarged part of the intestine. The lowest portion is the cavity formed in the yolk. It has acquired a roof by the ingrowth of the entoderm cells to form the floor of the intestine. This cavity usually remains for a considerable time.

31. The entoderm at first extends over the entire yolk. It later becomes restricted to a comparatively narrow strip along the axial line.

32. The floor of the alimentary canal is formed by the ingrowth below of the marginal cells of the entoderm. The ingrowth progresses from in front back. A lumen is not formed at once. The lumen is formed in the hind gut and in the gill region at the same time and gives abundant evidence that the alimentary tract is bilateral. The middle anterior part remains a solid mass of cells after the lumen has appeared both in front and behind this tract.

33. The anterior opening of the alimentary canal to the exterior is through the gill-slit in larvæ 1 mm. in length, *i. e.*, long before the mouth is formed. The first food enters through this gill-slit. The food current before the fish can swallow is kept up by a very highly ciliated gullet which extends from behind the gill region to near the hind gut.

34. The mouth does not appear till the larva has increased 3 mm., *i. e.*, to a length of about 4 mm., and during all this time the hyobranchial gill-slit functions as mouth. There is here found a condition similar to the one supposed by Dohrn to explain the replacement of the annelid mouth by a gill mouth.

35. Just in front of the notochord and near the region of the hyobranchial slit a strand of hypoblast cells extends up from the median portion of the alimentary tract to above the notochord. This strand of hypoblast cells lies in the region where Dohrn supposes the annelid œsophagus to have disappeared.

36. The hind gut soon becomes enormously enlarged and later a large number of long villi are developed.

37. The larvæ retain as an ancestral trait a large yolk sack, the yolk being quite minute. The sack is largely taken up by the large pericardium through which the long tubular heart extends from below and behind, upward and forward.

38. In conclusion: The fish in almost all its stages has become highly specialized. Many stages resemble very closely primitive conditions, but the conditions can probably in but few cases be looked upon as a simple reversion. Its development has, on the other hand, become extremely ichthyized and its egg stands at the end of the chain of eggs in which the *Branchiostoma* egg, the *Elasmobranch* egg, and the *normal fish* egg form links.

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With the further growth of the vesicle the yolk is usually infringed upon (fig. 145). Whether this is accomplished by the absorption of a part of the yolk, or whether it is simply crowded down, I am not able to say. I am inclined to believe that it is pushed down by the contents of the vesicle; otherwise the rearrangement of the yolk particles would soon fill up the gap made by absorption. However, in later stages of yolk absorption (fig. 136) the yolk is frequently eaten into in very much the same way without any apparent rearrangement of its parts.

After the vesicle has reached its largest size it acquires a cellular floor which corresponds with the *original* outline of the yolk (fig. 146). The vesicle is thus cut in two, a larger yolk vesicle and an upper vesicle which forms the enlarged portion of the hind end of the intestine. The cellular floor seems to be formed by an ingrowth from all sides. Both sagittal and transverse sections show that in earlier stages hypoblast cells extend in below the margin of the vesicle. These would simply have to extend still further centripetally to form a floor for the whole vesicle. The depression in the yolk is at the same time converted into a spherical vesicle, which may be termed the yolk vesicle. It is sometimes partially filled with a brightly staining substance, and as it is quite evident in entire specimens (figs. 84 to 86) I supposed it to be the yolk nucleus before I examined sections and learned the fate of that structure. In one larva the yolk vesicle was found at the ventral side of the yolk (fig. 85). The yolk vesicle remains longer than Kupffer's vesicle, and in fact the intestine extends some distance beyond it before it disappears. There seems to be no regularity in its disappearance, and probably no importance attaches to it after it is separated from the main vesicle.

The cellular floor of the vesicle rapidly thickens as the tail begins to grow out, while its communication with the alimentary canal is maintained (fig. 147). The dome-shaped part is probably constricted off at this time (12 protovertebræ), and the remainder of the vesicle is reduced to the caliber of the rest of the alimentary tract. My sections tell conflicting stories about the exact processes. Figure 78 shows an irregular cavity at the end of the mesenteron, which I consider the remains of the main vesicle. This cavity is connected by an area of disconnected cells with a vesicle lying dorsad of it. Figure 148, on the other hand, in which the tail is not as long as in figure 78, shows a dilation of the intestine dorsad, at the end of which lies a triangular cavity. It would appear that a part of the body of the original vesicle had been constricted off with the dome. The same appears to be true of figure 149. In both these larvæ the cells below this cavity are disarranged. The connection of this dorsal cavity, or vesicle, with the alimentary canal is now represented by the disarranged cells only. The two different structures, vesicle and disarranged cells, may, however, be harmonized. The dorsal vesicle disappears by the proliferation of cells from its wall into its cavity. These cells would at first be expected to be arranged somewhat differently from those in the older structure. In figure 78, which represents the older condition, the process has gone far enough to obliterate all of the body of the vesicle which had remained with the dome.

Neurenteric canal.—Several of the larvæ described above leave no doubt as to the meaning of the dome-shaped structure of Kupffer's vesicle. It is part of the neurenteric canal. In all late stages, as in figure 148, there are fewer cells above the neurenteric canal than in neighboring regions, and in several cases a tubular connection undoubtedly exists between the remains of the dorsal vesicle and the neural region.

In three cases (78, 148, 149) the dorsal portion is wholly or partly filled with cells. This is especially well seen in fig. 78, where the boundaries of the dorsal half of the canal are as well marked as those of the ventral half, but in which the dorsal half contains cells. The same is true of another larva (fig. 148), but in this instance the walls of the dorsal half are not so well defined. In another larva (fig. 149) a narrow but well-defined canal extends from the remains of the vesicle upward and then curves forward. This is probably only the posterior wall of the neurenteric canal. More or less well-defined lines extend from the anterior portion of the dome upward. The same condition can be traced in series of transverse sections. There seems then to be but little room for doubt about this structure. All the evidence indicates that in part at least it is the neurenteric canal.*

Kupffer's vesicle in general.—Kupffer's vesicle is evidently a rudimentary structure, without function in the majority of fishes. Several quite distinct views have been held as to the significance of this structure.

Kupffer, who first described it, and recently Henneguy, considered it to be the allantois of higher vertebrates.

Balfour homologized it with the postanal vesicle of elasmobranchs.

Cunningham, Ziegler, McIntosh and Prince, consider it to represent the invaginated gastrula (archenteron) of cyclostomes and plagiostomes.

Kowalewski holds in the main to the same opinion.

Henneguy formerly considered it the homologue of the primitive intestine of cyclostomes and amphibians. Many others who have seen the structure are noncommittal as to its significance.

The variety of opinions may in part be due to the variation of this structure in different fishes, for there is no doubt about the variability of the vesicle. It is difficult to see how a waning structure can represent a condition that has not appeared before phylogenetically and does not appear till in much higher vertebrates. I can not see how it can represent the allantois. Cunningham's theory is based on the presence of a canal between the vesicle and the blastopore. This canal is certainly not present in *Cymatogaster*, where the vesicle does not appear till long after the blastopore is closed.

Wilson considers the early stages homologous with the terminal part of the archenteron of amphibians and the later stages homologous with the postanal vesicle of elasmobranchs.

The fact that in the majority of fishes it arises long before the alimentary canal and disappears, or at least diminishes, before the alimentary canal is formed argues against its homology with the postanal vesicle of elasmobranchs. It must be conceded, however, that in fishes the alimentary canal is late in making its appearance as compared with elasmobranchs. The alimentary tract is retarded in teleosts for some reason or other. The caudal vesicle is functionless in elasmobranchs and the

causes which brought about a retardation of the functional intestine would not necessarily affect the functionless postanal section. It thus happens that the postanal vesicle in teleosts appears as Kupffer's vesicle before any lumen is formed in the intestine. In *Serranus*, at least, it lies at the end of a postanal gut. In the trout, according to Henneguy, and in *Cymatogaster* it is at least in part incorporated in the intestine. Kupffer's vesicle is, moreover, the only part of the intestine raised from the yolk before a floor is acquired. [In *Serranus* (Wilson, 1890) this raised portion is not confined to Kupffer's vesicle.] Kupffer's vesicle, in *Cymatogaster* at least, is more than the postanal vesicle of elasmobranchs. The archenteron, the postanal vesicle, and neurenteric canal all seem represented by it.

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* I want to point out here the possibility that the neurenteric vesicle alone represents the caudal vesicle of other teleosts, and that its connection with the lower part of the vesicle which is converted into the hind gut is after all due to the precocious development of the hind gut, which thus extends past the region of the original Kupffer's vesicle before the growth of the tail has carried the latter farther back. In that case the postanal gut would be represented by the dorsal wall of the hind gut; *i. e.*, the region between the hind gut and the neurenteric vesicle. This would account for the fact that I have not been able to find any other structure which might be homologized with the postanal gut frequently described for teleosts. The lower or main part of the vesicle may then be looked upon as the archenteric cavity.

In *Cymatogaster* it is seen that a part of this vesicle is for a time the direct continuation of the alimentary tube and that during this time a narrow slit (neurenteric canal) extends upward from its anterior half. This upward extension is formed in *Ctenolabrus*, according to Agassiz and Whitman, at the closing of the blastopore. But the condition described by them I have never been able to see in any of the pelagic eggs examined by me.

If we consider a part of the vesicle the homologue of the postanal vesicle of elasmobranchs it remains to be shown why in *Cymatogaster* it forms part of the permanent intestine. The cause is not far to seek. The embryo, in the first place, is shortened on account of the small yolk at the periphery of which it is formed, the tail being represented by a large knob of undifferentiated cells. On the other hand, the alimentary canal is precociously developed, owing to viviparity, and the whole of the hypoblastic area is utilized in forming the permanent alimentary tract.

Agassiz and Whitman (1884) traced Kupffer's vesicle in several species of pelagic eggs. In the formation they found what Kingsley and Conn had already well described. It "arises by the fusion or confluence of a cluster of granules. * * * In *Ctenolabrus* the granules appear soon after the embryonic ring passes the equator, when the length of the embryo is about four-fifths of the diameter of the ovum. Its maximum diameter when fully formed is seldom more than 0·03 mm. During its formation, till it reaches its maximum size, it lies beneath the chorda and the entodermic stratum and has no sort of relation with any tubular structure whatever. * * Ventrally and laterally it is bounded by periblast material. * * * It grows smaller after the closure of the blastopore, and during this period in a number of species it rises from the periblast into the entoderm, where it vanishes." Behind this they have found a variable number of secondary caudal vesicles.

Henneguy (1889) describes some of the distinguishing phases of Kupffer's vesicle in the trout (*Salmo fario.*) (He first described it as early as 1880.) The first indications of a modification in the region of the future vesicle were noticed very early and the vesicle itself was quite large when but two or three protovertebræ had been formed. The cells in this region are larger than the others and are undergoing division. There are but few of these cylindrical cells, and they are in contact with the periblast, and later one sees "une invagination se produise dans l'embryon pour former la vésicule." This mass of cells is the first indication of Kupffer's vesicle. Its growth must be quite rapid, for it is 0·11 mm. long and 0·09 wide when but two or three protovertebræ are formed, and occupies "la place de la corde dorsale," *i. e.*, it is entirely surrounded by hypoblast. It lies just in front of the caudal swelling "au point où commence à se differencier le mésoderm." He points out that it differs in its position in the entoderm

from the condition usually prevailing in fishes where it projects into the vitellus. He then states that this difference is of no importance (1881), for in a later stage the vesicle "peut faire saillie hors de l'embryon" and thus become as in other fishes. In other words, the process described by Agassiz and Whitman is here said to be inverted. In a stage with twenty-two protovertebræ it is figured as the enlarged posterior end of the alimentary canal. It would here, then, permanently form a part of the intestine, and in this respect agree with the middle vesicle in *Cymatogaster*. It elongates antero-posteriorly and becomes pyriform. It comes directly in contact with the nervous thickening above. It is only the first indication of the digestive tube. It is important on account of its relation with the nervous system and the notochord and the region corresponds to the region of the neurenteric canal of other vertebrates. He has never found a canal leading to the exterior. He considers the opinion of Kingsley and Conn, Agassiz and Whitman, Cunningham, Ziegler, that the vesicle lies between the periblast and the hypoblast, to be based on an error of observation.

Frequently there exists below the vesicle or in its neighborhood a hemispherical depression in the surface of the vitellus. (It is possible that in this case the vesicle divides into two, a yolk vesicle and the intestinal vesicle seen in *Cymatogaster*.) He thinks the original opinion of Kupffer may still be defended when one considers that it is the first indication of the alimentary canal in the neurenteric region and that the allantois of higher vertebrates is but a diverticulum of the intestine appearing very early in front of the neurenteric canal.

In *Serranus*, according to Wilson, the vesicle appears as an up-pushing of the hypoblast, which had previously become columnar, and a down-pushing of the periblast. It disappears by the proliferation of cells from its own walls. It is formed some distance behind the future anus and lies in the postanal gut. In this respect it greatly resembles the postanal vesicle of elasmobranchs, with which it is homologous. "Before Kupffer's vesicle is folded off it represents the terminal dilatation of the archenteron itself, and in this phase is to be compared with the dilated posterior extremity of the archenteron in certain amphibian gastrulas."

McIntosh and Prince (1890) observed the vesicle in a number of species. They find that it arises, as Kingsley and Conn have described, by the union of a number of granules or small vesicles. They found secondary vesicles quite frequently, sometimes extending "all along the ventral line almost to the pectoral region." Its contents are usually homogeneous and clear, though granules are occasionally present. They claim to have traced a neurenteric canal from the vesicle to the blastopore at the time the latter closes.

Formation of liver and air bladder, mouth, thyroid gland, and hypophysis.—In a preceding chapter the intestine was described from its first appearance until, in larvæ 1 mm. long, it forms a simple tube from the hyobranchial gill-slit to the anus. In the stages succeeding that the rudiments of the liver and of the air-bladder make their appearance. Parts of the tract are at the same time otherwise modified.

In larvæ 1·8 mm. long (figs. 150, 156, 157) the intestine is broad and depressed just behind the hyobranchial slit, and its walls are composed of ciliated cells 18μ high. In the roof the nuclei of the cells are slightly nearer the free ends of the cells and nearly all are on the same level.

In the floor there are besides this layer of cells a few scattered ones among the bases of the others (figs. 156, 157). Towards the back part of the gullet the lumen

Fig. 113. Outlines of another larva of the same ovary showing Kupffer's vesicle.

Fig. 114. Outlines of a median section of another larva of the same stage.

Plate CVIII.

Figs. 115-118. Sections further illustrating the hypoblastic areas of the stage represented in fig. 76. Hypoblast shaded.

Fig. 115 is a section parallel to fig. 15, and much more lateral in its position, showing the relation of the hypoblast (shaded) to the auditory thickening.

Fig. 116. A cross-section passing just above the anterior end of the chorda. It cuts the auditory thickening at "*an*" and the lateral gill-pouches. See *aa'* in fig. 76.

Fig. 117. Another section of the same series through the middle of the body, showing the floor cells of the alimentary tract. See *bb'* in fig. 76.

Fig. 118. Another section through Kupffer's vesicle. See *cc'* in fig. 76.

Figs. 119-124. Outlines of 6 sections from a larva slightly older than fig. 76. The larva was cut into 46 sections. Fig. 119 represents the 36th section from behind; fig. 120, the 35th; fig. 121, the 34th; fig. 122, the 31st; fig. 123, the 18th; and fig. 124, the 13th section. The lumen of the intestine is just forming. Figs. 119-122 represent the gill region, the remainder the posterior region; fig. 124 showing especially well the wide potential slit of the intestine just in front of Kupffer's vesicle.

Figs. 125-127. Three sections of the intestine of another larva from the same ovary between the regions represented by figs. 122 and 123.

Plate CIX.

Figs. 128-135. Eight cross-sections of a larva in the stage represented by fig. 77. The larva was cut into 59 sections. The figures represent the following sections from in front backward.

Figures.	Section.
128	12
129	17
130	18
131	22
132	24
133	41
134	46
135	53

The sections are somewhat oblique, so that the dextral half of the figures are further forward than the sinistral. Figs. 129, 132, and 133 are magnified less than the others.

Fig. 128. The section passes through the left hyobranchial slit, the auditory thickening, and the heart, which is still a solid mass of mesoblast cells.

Fig. 129. The alimentary canal just behind the gill invagination.

Fig. 130. The next section, the sinistral half of the alimentary tract, solid.

Fig. 131. A section through the solid œsophagus, the floor cells distinct from the roof cells

Fig. 132. Outlines of a section a little farther back.

Fig. 133. Outlines of the intestine much farther back.

Fig. 134. Section through the widest part of the intestine and through Kupffer's vesicle.

Fig. 135. Section through the neurenteric portion of Kupffer's vesicle.

Plate CX.

Fig. 136. Sagittal section of a larva about 1 mm. long and with about twenty protovertebrae; somewhat diagrammatic, from a number of sections. The heart is shortened and the pericardial chamber reduced by reagents. A large number of spermatozoa are seen in the intestine. The yolk has been eaten into. The auditory capsule is much nearer the surface and has been added to show the relation of the parts at this time.

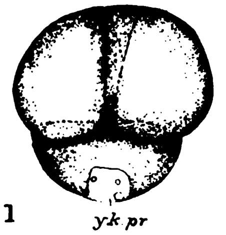
Fig. 137. Details of the gill region near the side of a similar larva.

migrated in through the gill-slit. In the ciliated gullet the cells are 22μ high. On the roof this tract extends farther caudad than on the floor, where it does not extend beyond the gill thickenings. The walls of the mid gut are again of a low epithelial nature, while the cells lining the hind gut are of quite another nature. They are high and the small nucleus is situated near the base of the cells, where the contents are slightly granular. The center of the cells is a large unstainable space very variable in size. The free ends of the cells are again granular. Some of these cells contain deeply stained bodies similar to those found in the lumen, and it seems very probable that these bodies have been swallowed by the cell and are in process of reduction by intracellular digestion. At the anus the epithelium of the roof of the intestine is continuous with that of the floor of the combined segmental ducts. The cells of the floor of the intestine are continuous with those of the ventral surface. The segmental duct empties just behind the anus and not into a cloaca or into the intestine.

In an earlier stage it was noticed that the mouth was first indicated just behind the eye. The conditions obtaining in larvæ of this stage are shown in figs. 167 to 171 (3·2 mm.); the mouth is essentially like the other gills, especially the spiracular, and agrees in all major points with the condition described by Dohrn. That is, the mouth is further developed laterally than medially and some distance behind the point where it attains its full development. In the larvæ 1 mm. long I was unable to trace the hypoblast cells much beyond the notochord. In other words the alimentary tract begins in the hyobranchial region in those larvæ. It soon extends forward in the median line and, as far as I could determine, the outgrowth of hypoblast to form the hyomandibular slit takes place later than that to form the hyobranchial. In larvæ 1·8 mm. long the hypoblast extends outward to the ectoderm just behind the eye. This I have identified as the first indication of the future mouth (figs. 154, 181). In these larvæ the hypoblast does not yet extend to the anterior end, and the mouth is a strictly bilateral structure. The hyomandibular evagination is separated from the mouth evagination by a more restricted region of hypoblast (fig. 153). This evagination does not differ materially from the mouth evagination. In each case the ectoderm is two layers thick where the hypoblast touches it. But one of the gill evaginations has been completed and the second is in process of formation (figs. 150 and 151). The details of the completion of the mouth have not been traced. It is not functional when the larvæ are 4 mm. long and in fact the lumen does not extend forward any farther than in the 3 mm. larvæ.

The mouth is completed shortly after the larvæ have reached 4 mm. This lateness of the appearance of the mouth seems to me to be one of the most remarkable circumstances connected with the development of the alimentary tract. Thus while the intestine becomes functional when the larvæ have reached a length of 1 mm. the mouth is not formed till they are over 4 mm. long—not in fact till the liver has long been functional, the air-bladder well developed—not till all the glands derived from the hypoblast are well developed. Not only is the mouth late in appearing but the whole canal from the gill-cavity forward is also late in forming. While this may be due to retardation, since ingress to the canal is had through the first gill-cleft, the conditions impress one with the suggestion of Dohrn that the present mouth of vertebrates is not the original mouth, but is of comparatively late origin. How one structure may replace another as a mouth is well illustrated by *Cymatogaster*, where a new structure, the hyobranchial gill-cleft, functions as a mouth for a long time. It would

PLATE XCIV.



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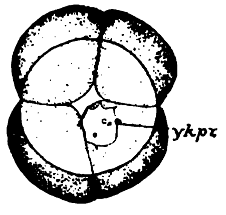

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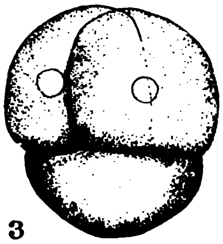

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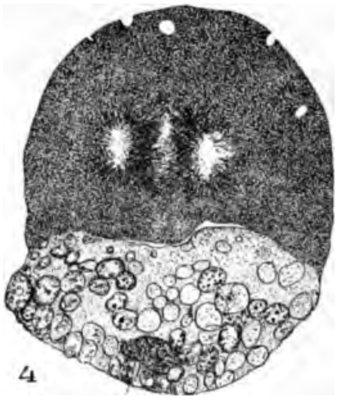

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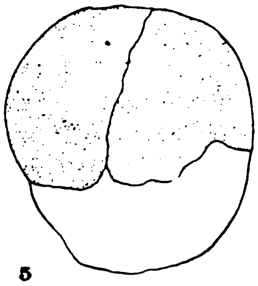

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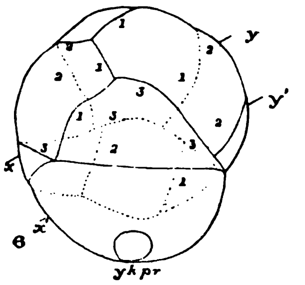

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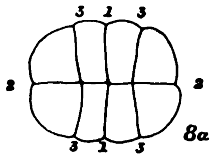

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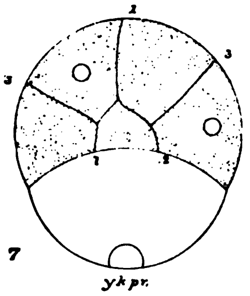

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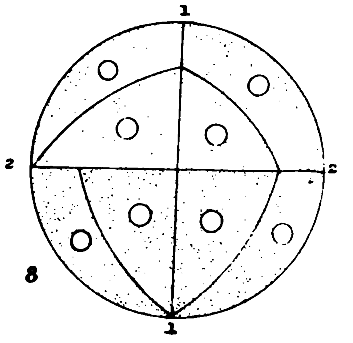

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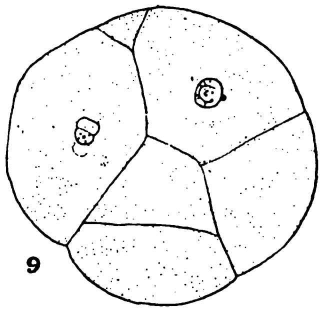

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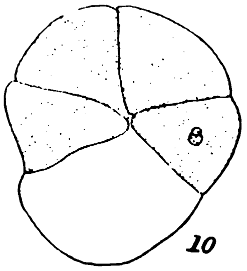

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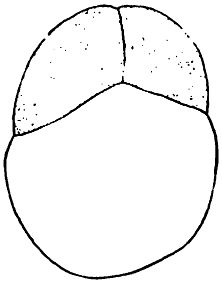

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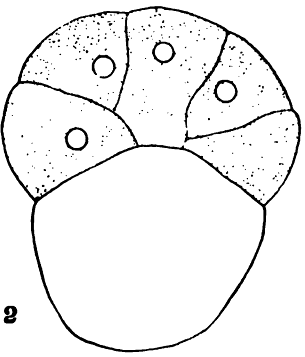

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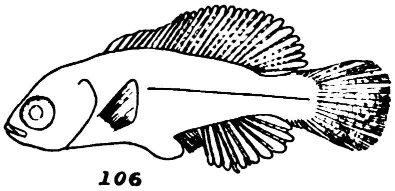

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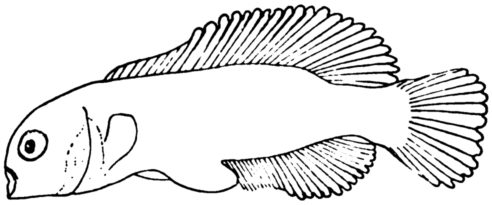
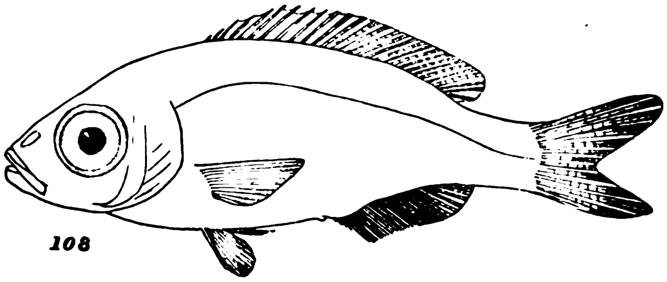
107





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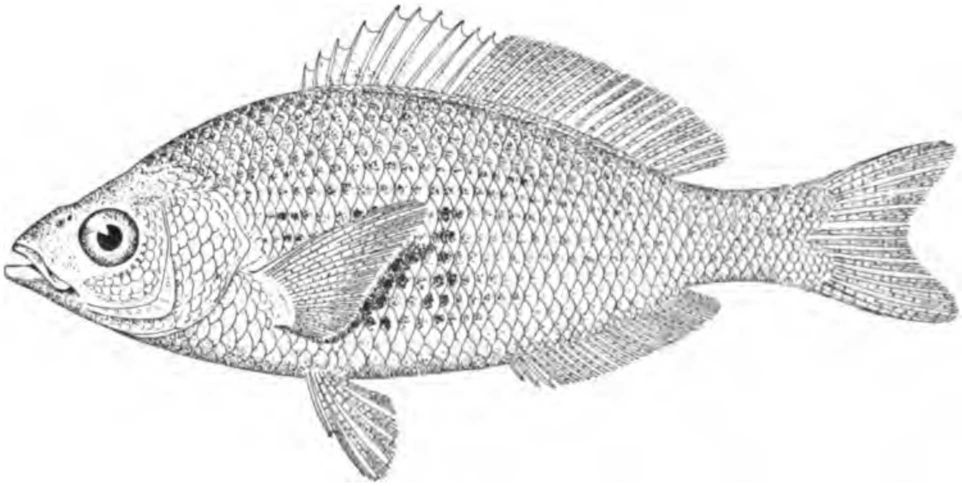
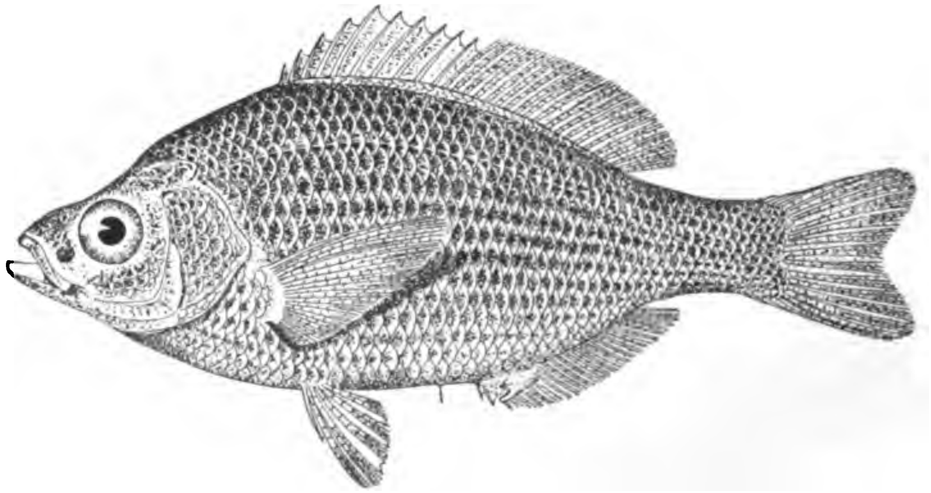
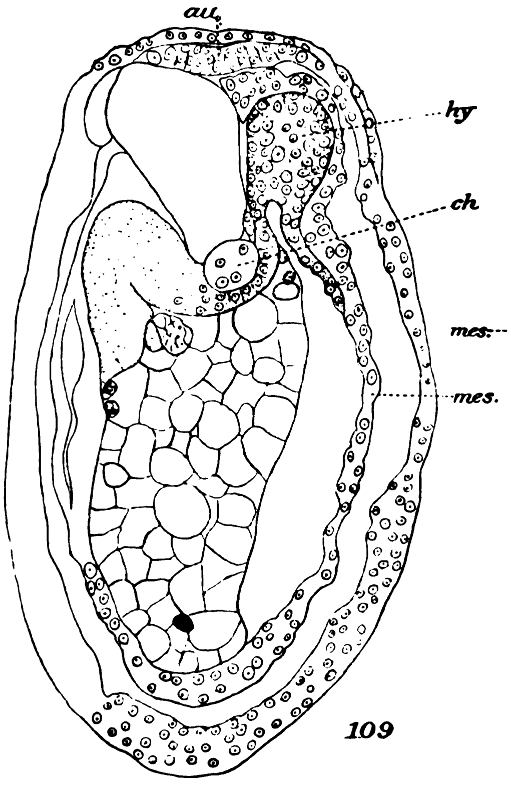


108*a*. CYMATOGASTER AGGREGATUS. Adult female.



108*b*. CYMATOGASTER AGGREGATUS. Adult male.



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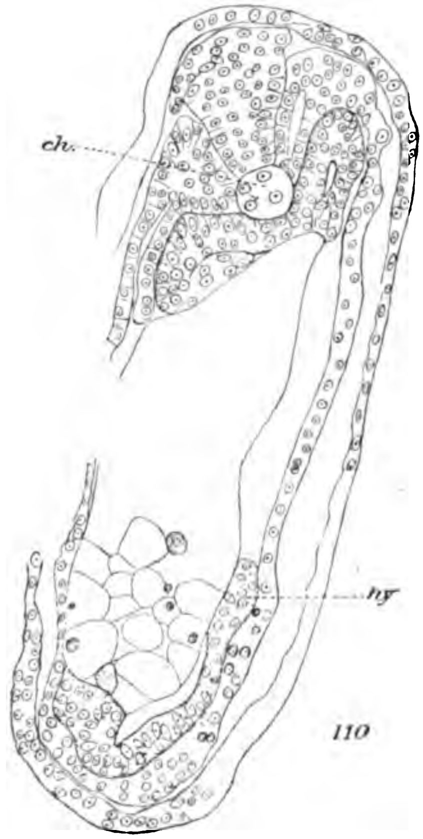

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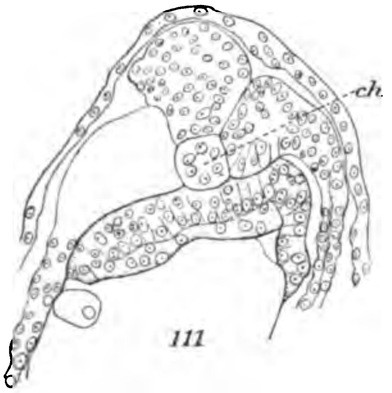

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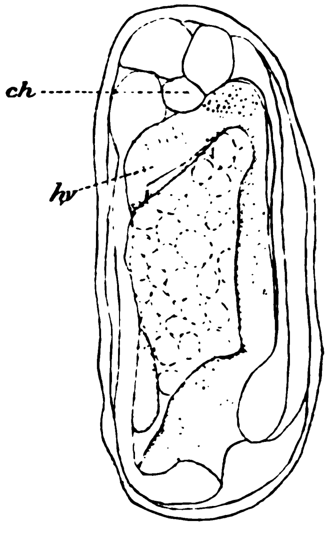

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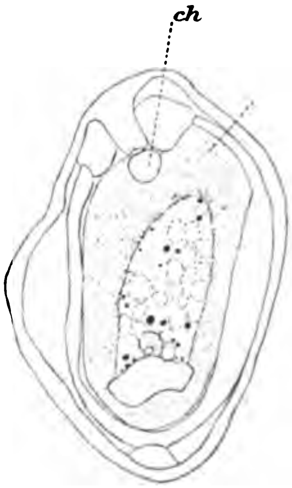

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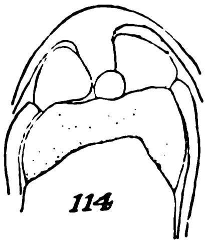

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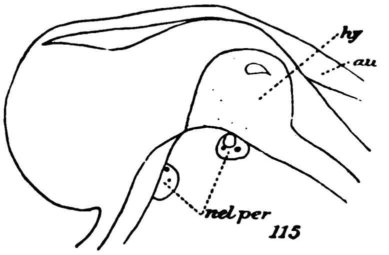

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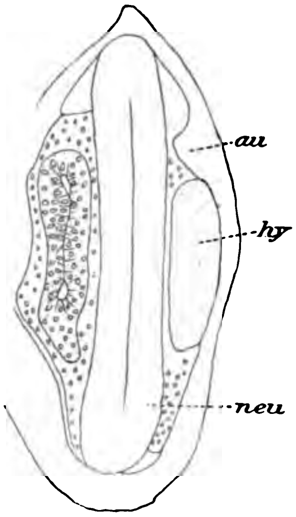

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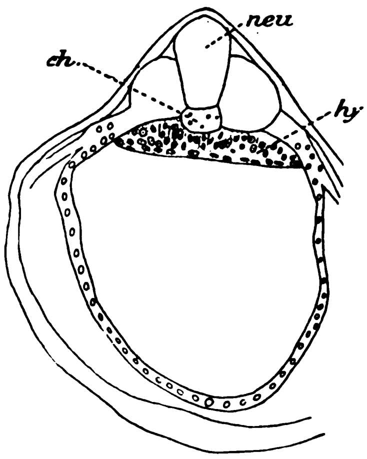

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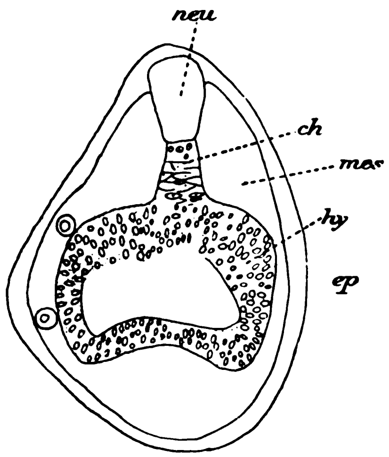

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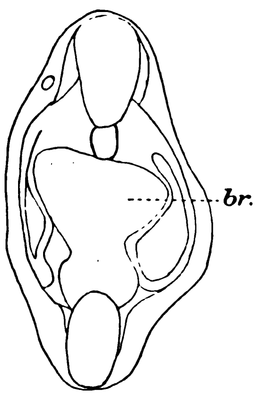

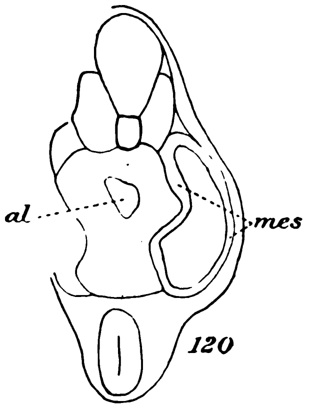

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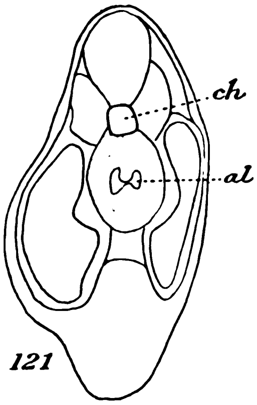

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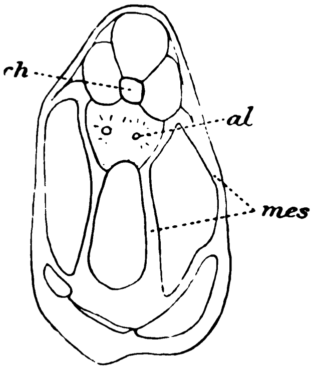

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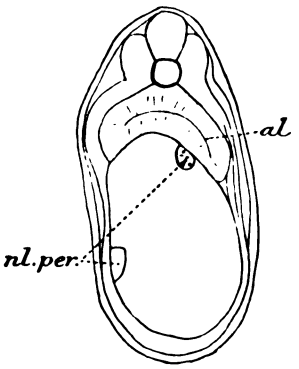

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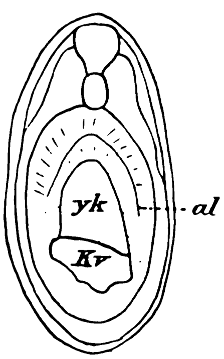

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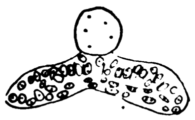

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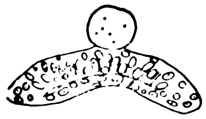

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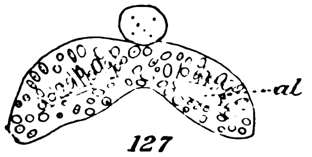

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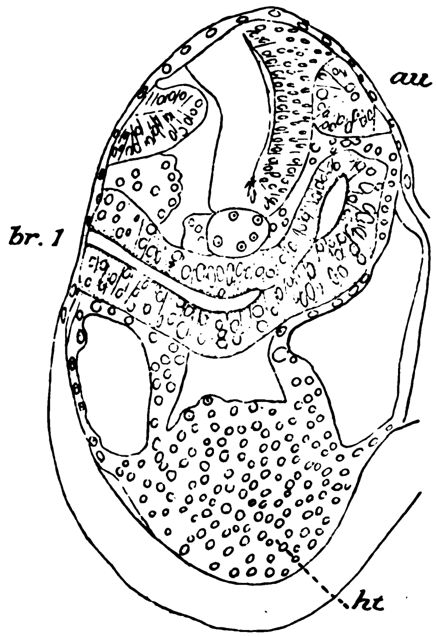

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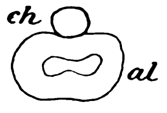

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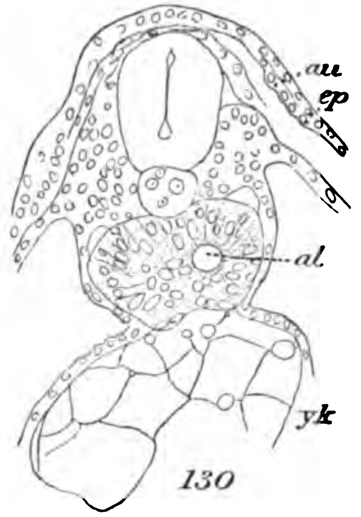

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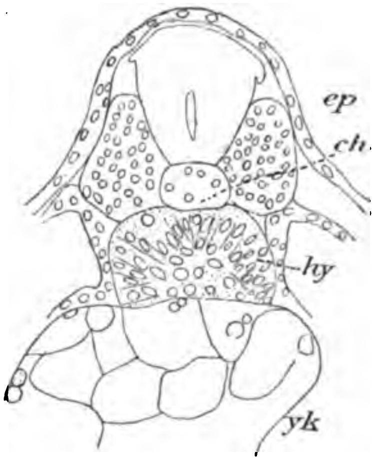

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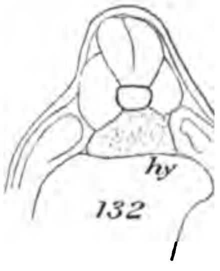

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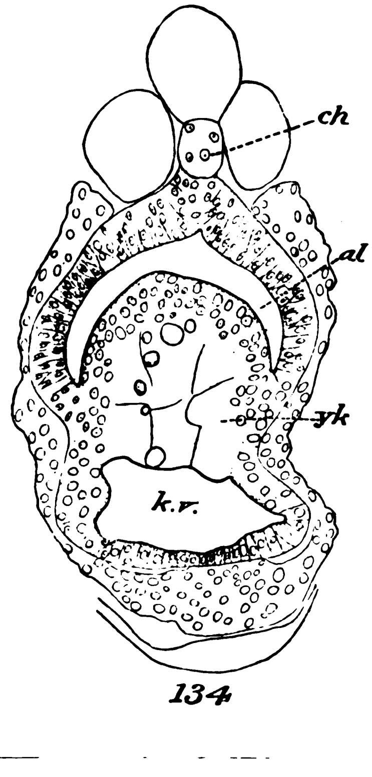

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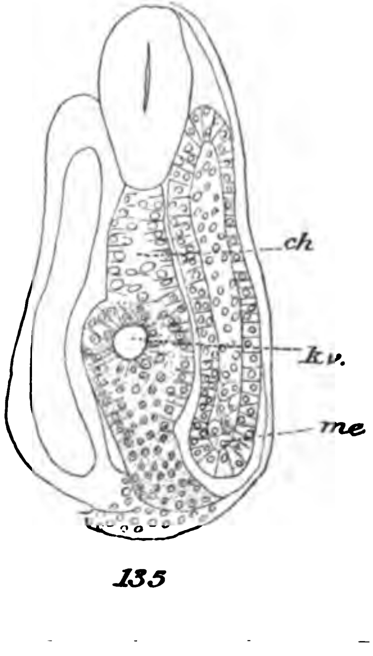

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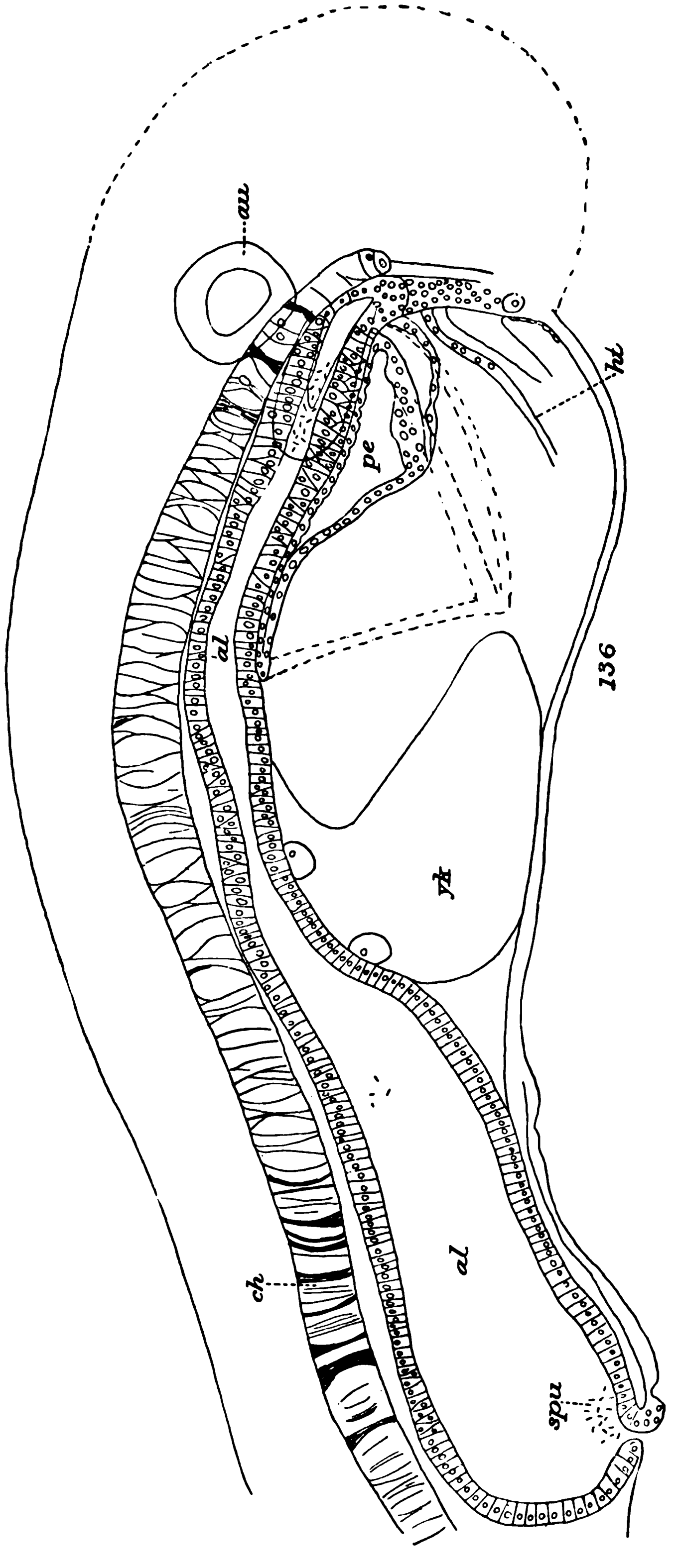
PLATE CX.



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C.H.S. del

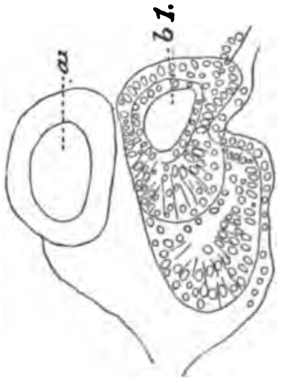

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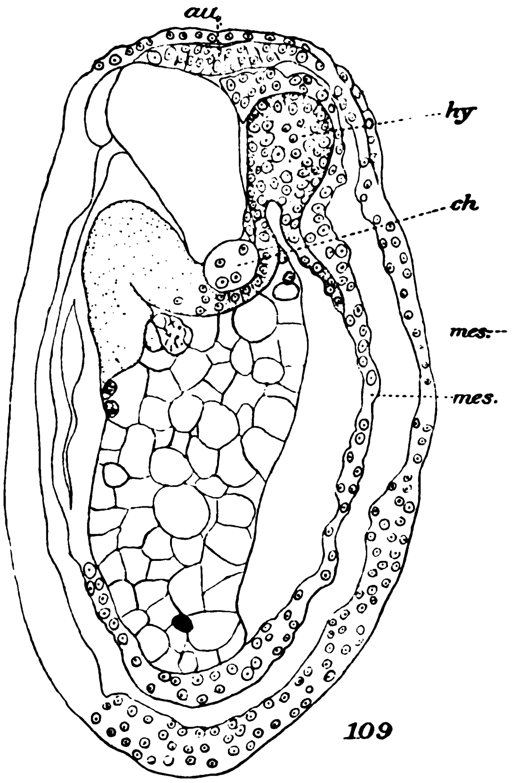
PLATE CVII.



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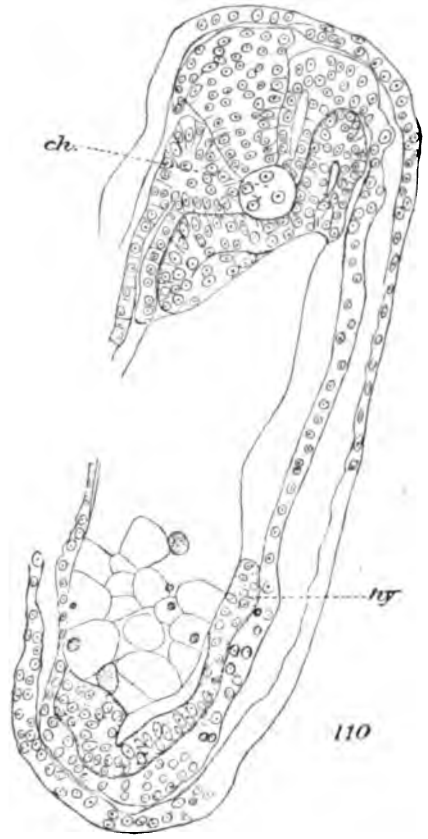

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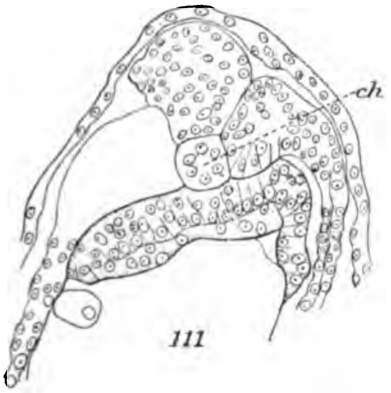

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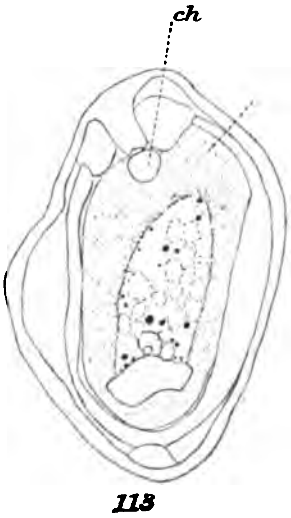

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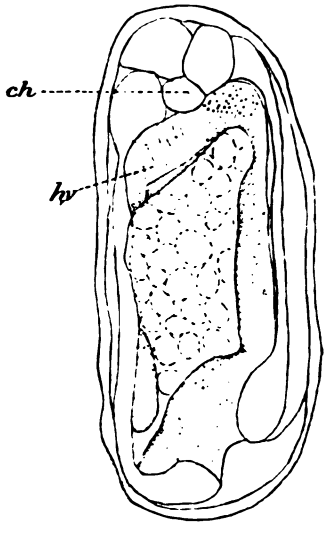

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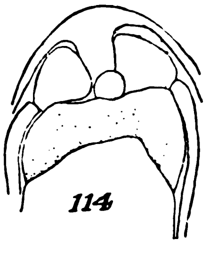

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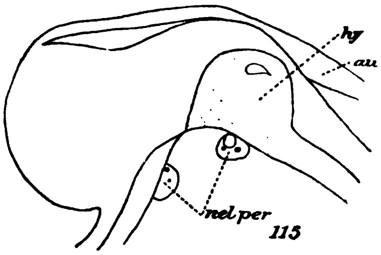

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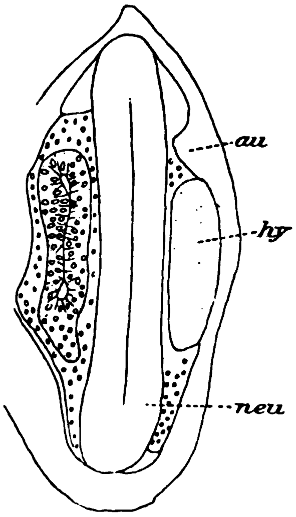

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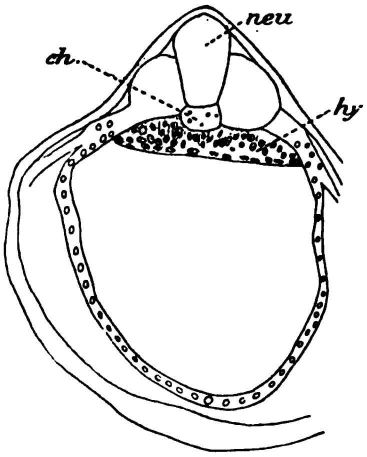

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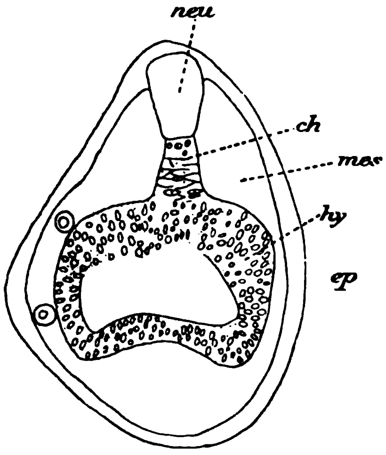

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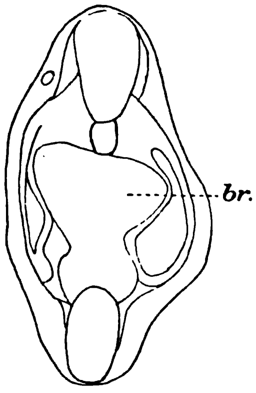

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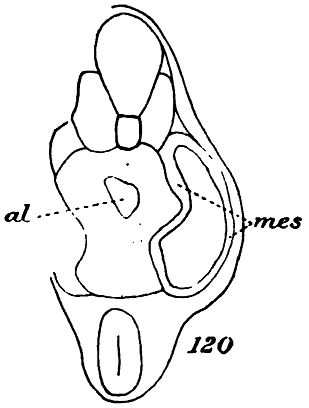

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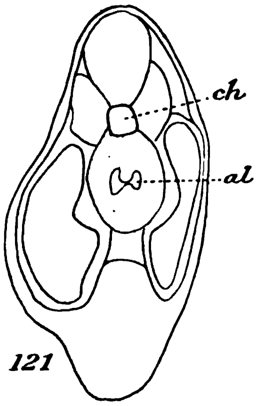

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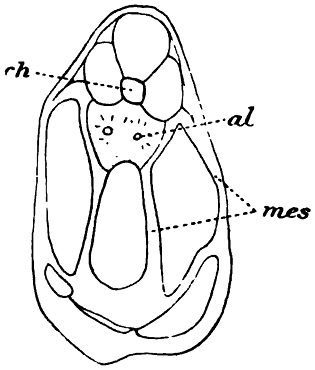

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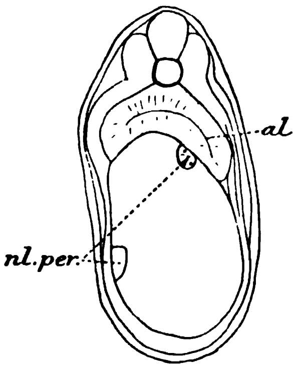

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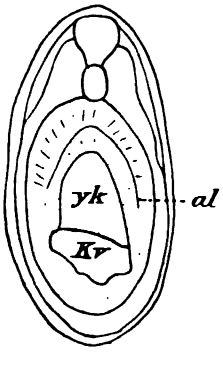

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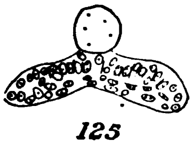

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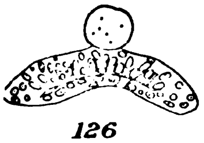

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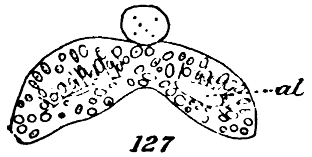

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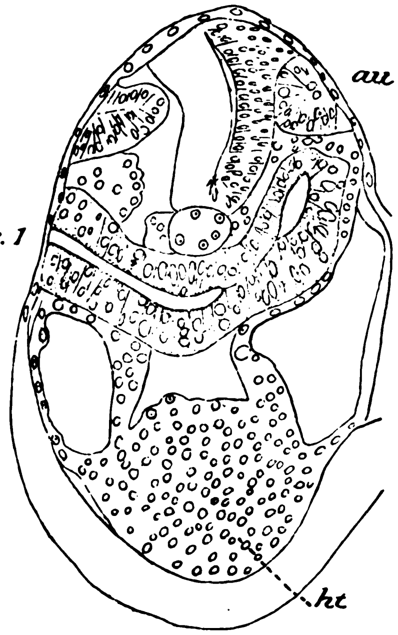

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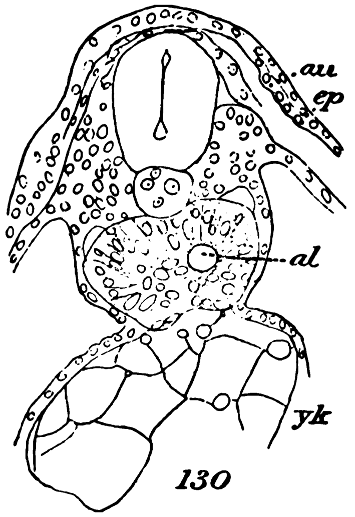

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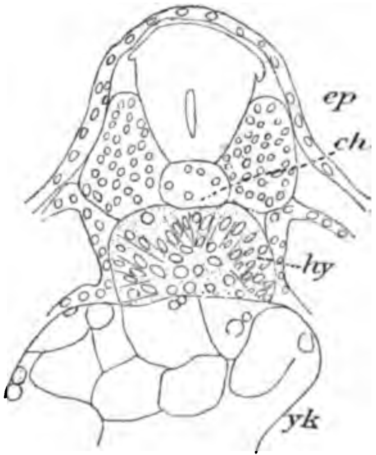

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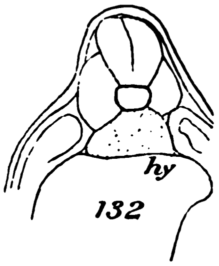

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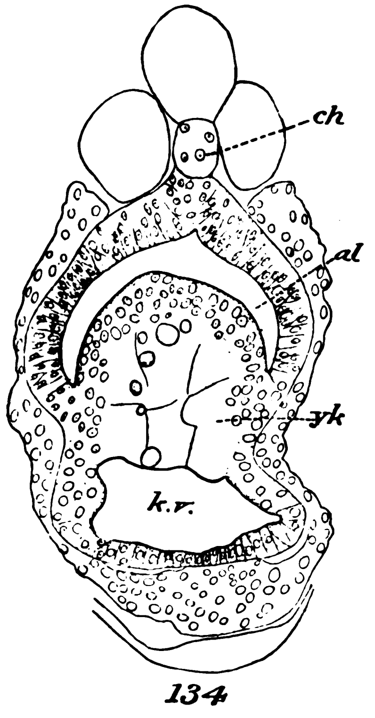

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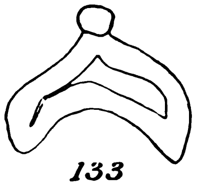

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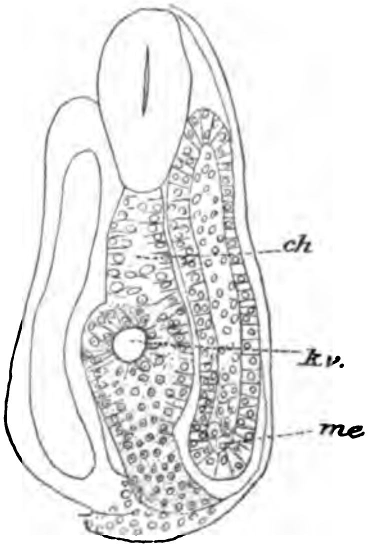

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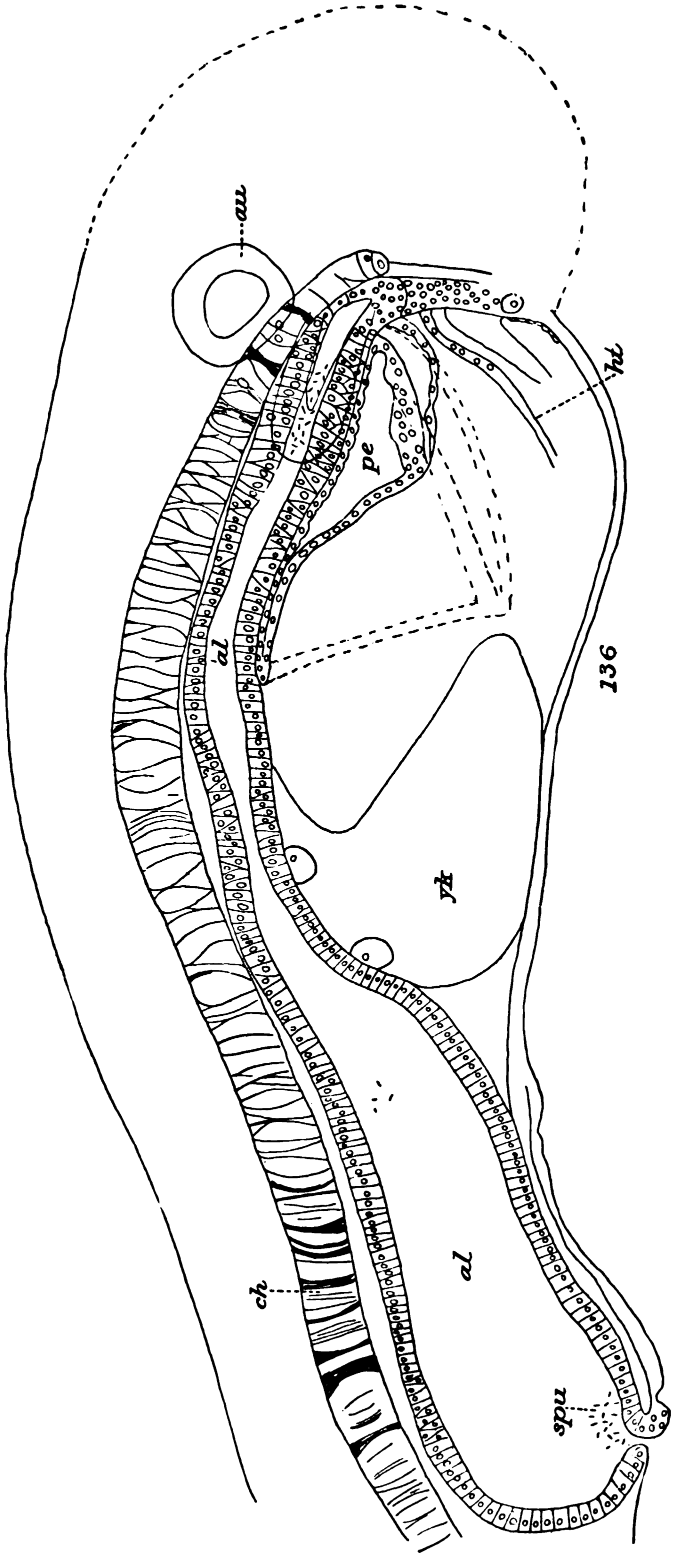

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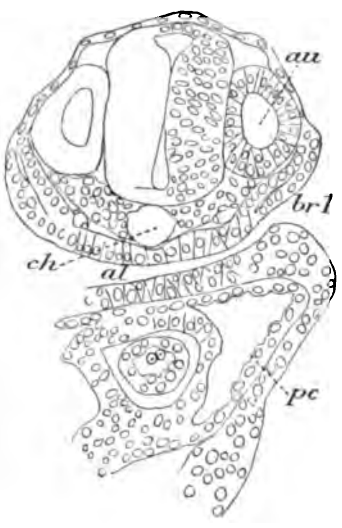
137



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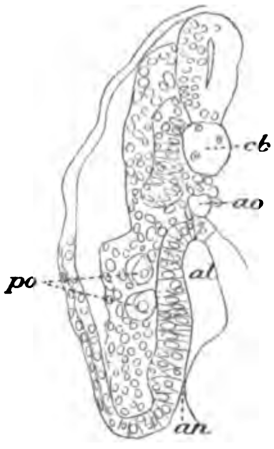

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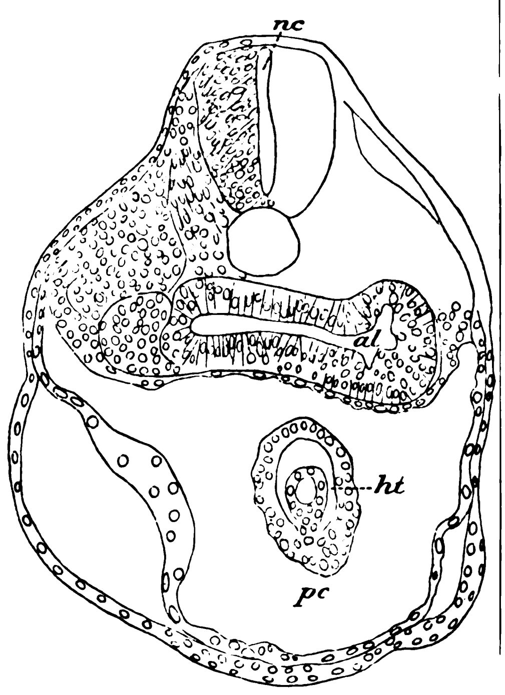

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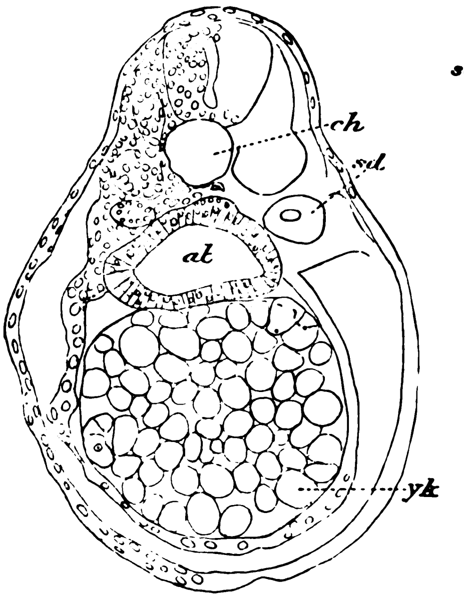

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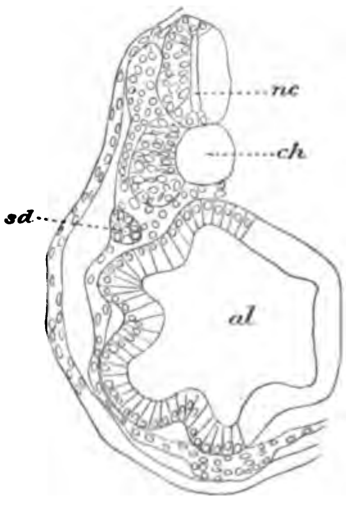

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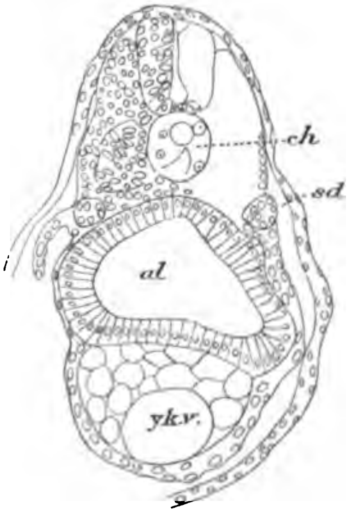

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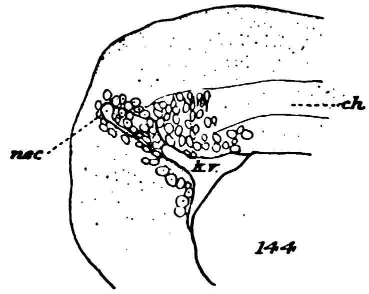

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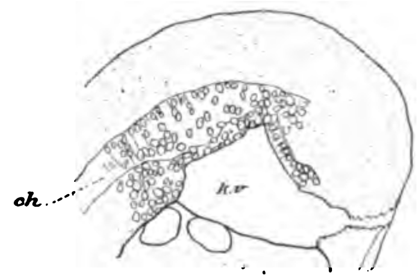

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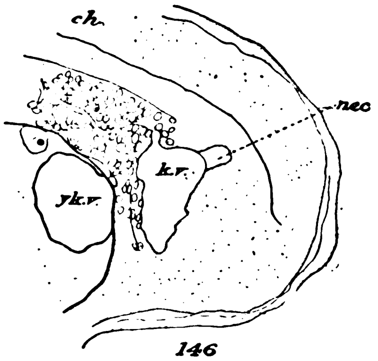

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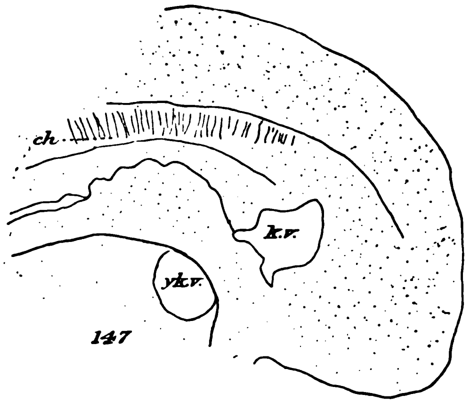

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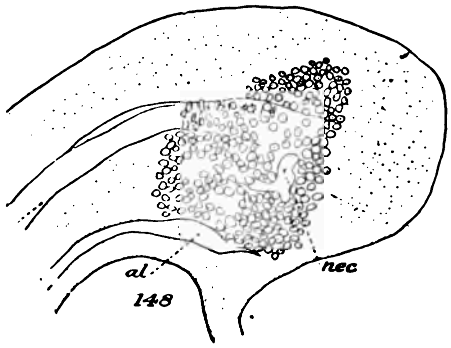

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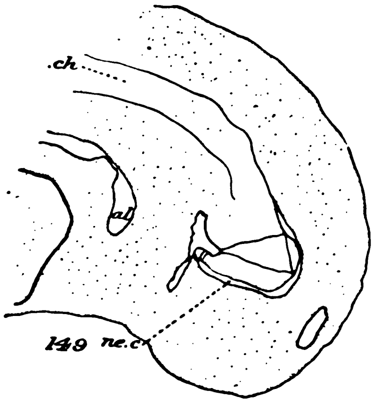

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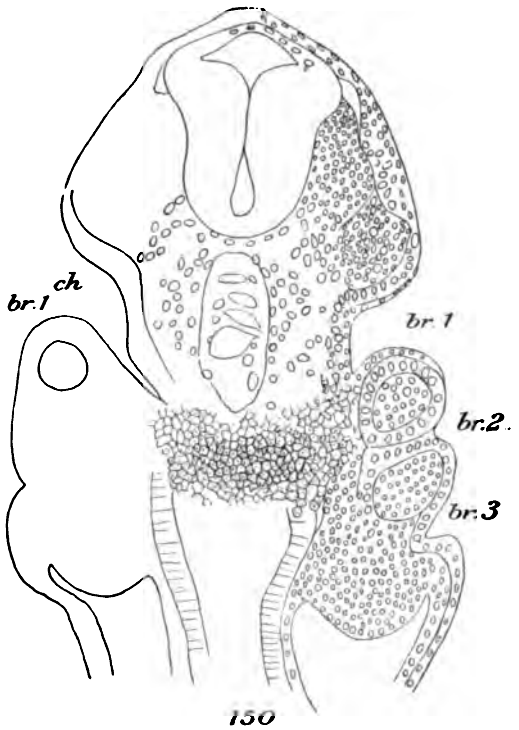

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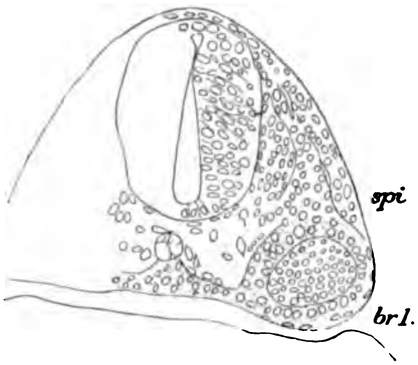

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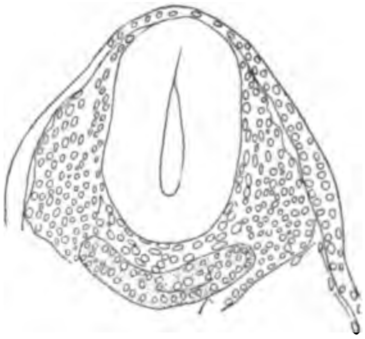

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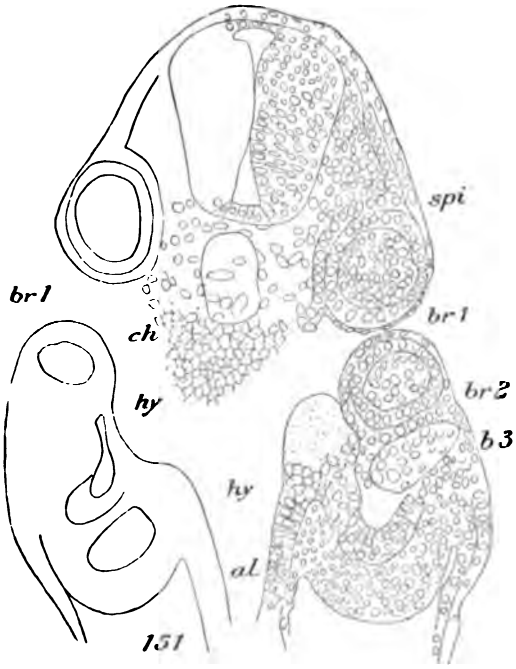

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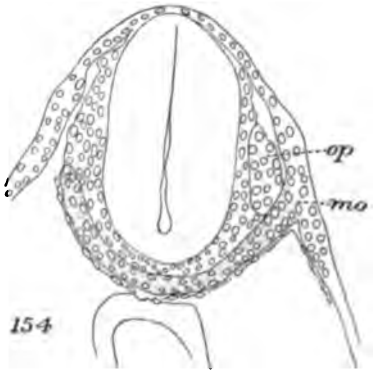

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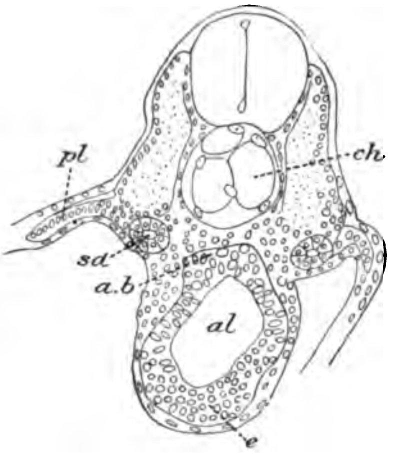

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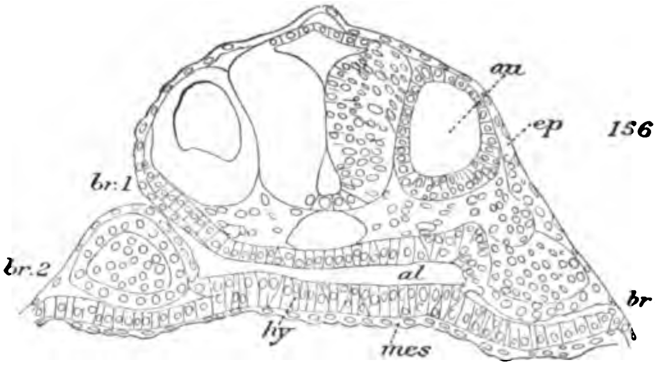

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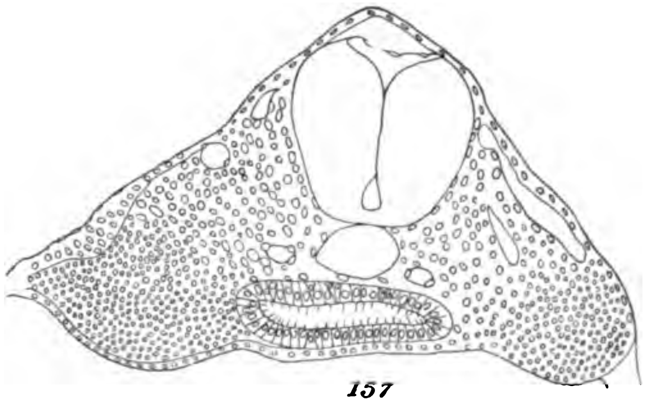

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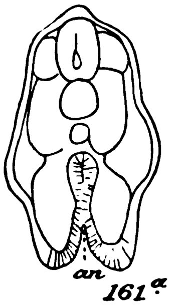

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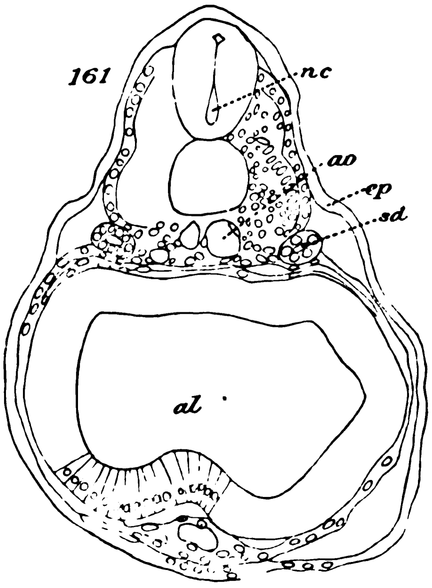

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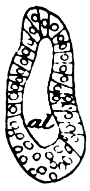

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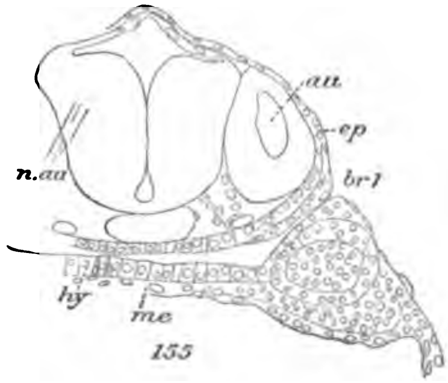

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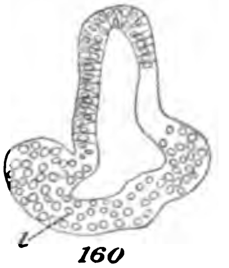

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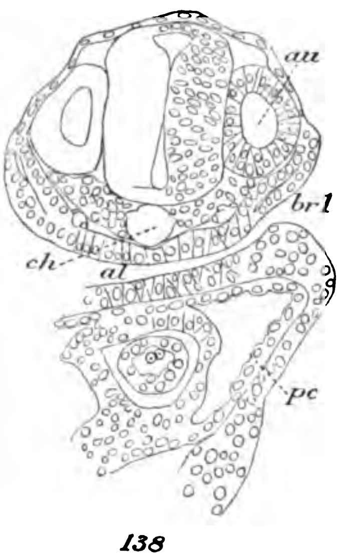
PLATE CXI.



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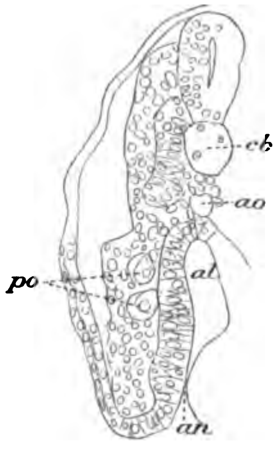

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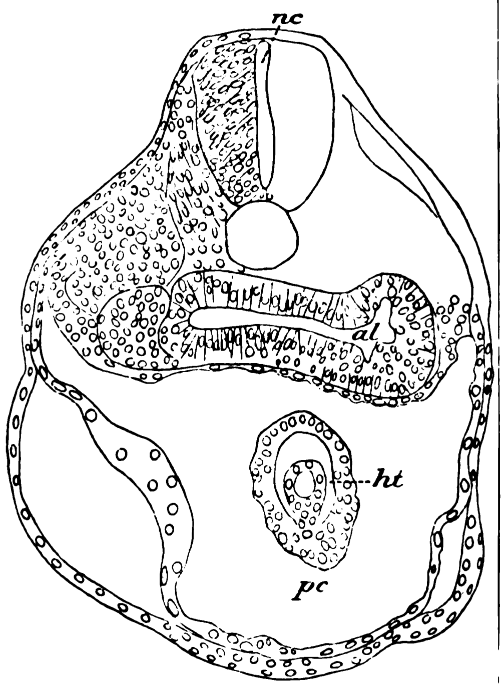

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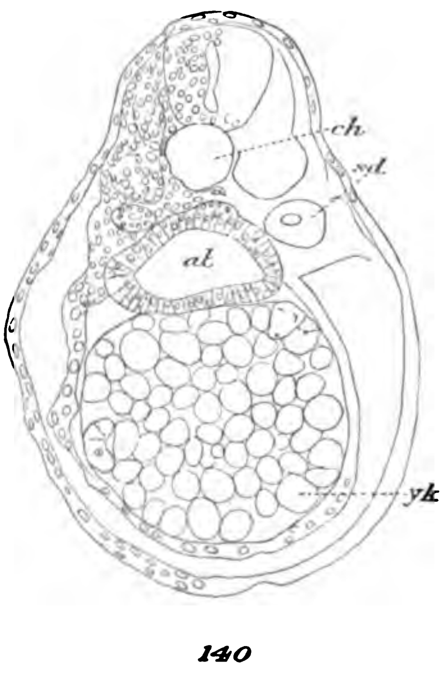

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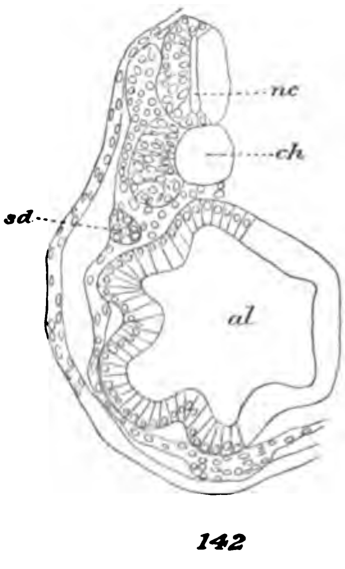

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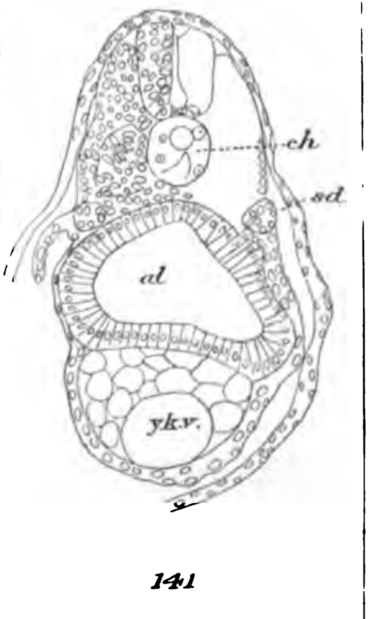

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PLATE CXV.

Fig. 162. Outlines of a sagittal section of a larva about 1·9 mm. long, to show the relative positions of the liver, air-bladder, and yolk.

Fig. 163. Cross-section of a similar larva through the air-bladder.

Fig. 164. Another section a little farther back.

Fig. 165. Sagittal section through the midgut of a larva 2·5 mm. long. The yolk is reduced and the liver much more highly developed. The bile sac is just forming.

Fig. 165*a*. An enlarged sagittal section through the anus and nephridial opening of a larva 3·2 mm. long. The rudiments of the reproductive organs are seen in *po*.

Fig. 166. Sagittal section of alimentary tract of larva 3·2 mm. long. Posterior part on right below.

Fig. 166*a* and *b*. Some of the cells of the hind-gut enlarged.

PLATE CXVI.

Fig. 167–171. A series of sections from the same larva as fig. 166. The sections are successively nearer the lateral surface of the embryo. These sections show the relation of the hypoblastic evaginations to each other at varying distances from median plane. The gill-structures do not yet meet below and are not visible in fig. 166.

Fig. 167. Several sections removed from 166.

Fig. 168. The next section, showing the mandibular, spiracular, and three gill evaginations.

Fig. 169. The next section, the mandibular, spiracular, and hyobranchial not connected by hypoblast laterally.

Fig. 170. Two sections removed from 169.

Fig. 171. Two sections removed from 170.

Figs. 171*a*–174*a*. Cross-sections through the thyroid and gill regions of a larva 3·2 mm. long. (Figs. 173, 174 are on plate CXVII.)

Fig. 171*a*. Cross-section of the thyroid gland.

Fig. 171*b*. Through the same one section behind 171*a*. Showing connection with hypoblast cells.

Fig. 172. Oblique section through spiracle on left and just behind hyobranchial on right.

PLATE CXVII.

Figs. 171*a*–174*a*. Cross-sections through the thyroid and gill regions of a larva 3·2 mm. long. (Figs. 171*a*, 172 are on plate CXVI.)

Fig. 173. Six sections behind 172; the right through the posterior part of the auditory capsule, the left through the hyobranchial.

Fig. 174. Through the posterior part of the gill region; the left through the upper (posterior) part of a gill pocket, the right through the anterior (lower) of another. Ciliated region of the gullet.

Fig. 174*a*. Lateral margin of the gullet, two sections farther back.

Fig. 175. Right half of a horizontal section of a larva 2·5 mm. long. All the gill-slits potentially complete.

Figs. 176–178. Three parallel sections; 176, sagittal of a larva 4 mm. long; the mouth not yet open; some of the posterior gill-slits open. The ciliated gullet highly differentiated from the other alimentary region.

PLATE CXVIII.

Figs. 179–183. Development of gills as seen in living larvæ viewed as transparent objects.

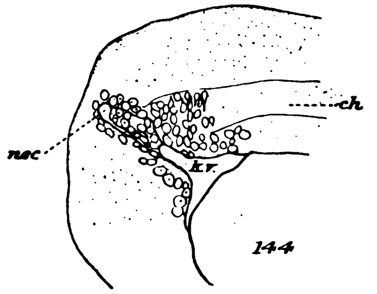
Fig. 179. Larva, 0·9 mm. long.

Fig. 180. Gill region of a larva 2·5 mm. long.

Fig. 181. A little older larva, showing the mandibular and hyomandibular slits and their relations to the hyobranchial and succeeding slits.

Fig. 182. Gill region of a larva 4·1 mm. long. × 2.

Fig. 183. Gill region of an older larva in which the conditions seen in figs. 94–100 are approached.



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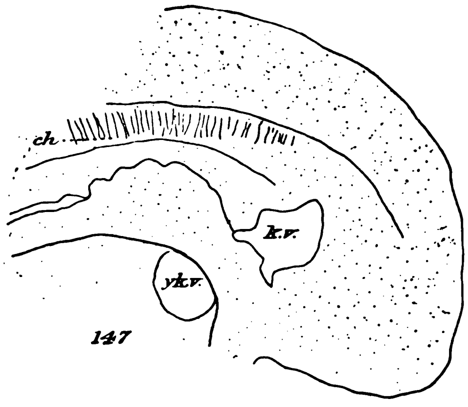

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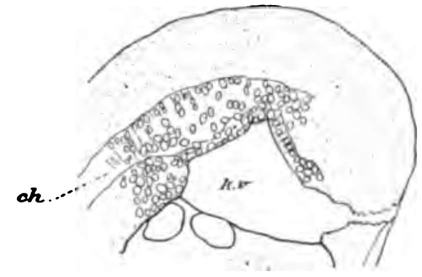

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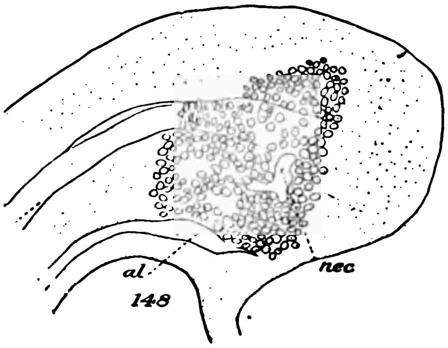

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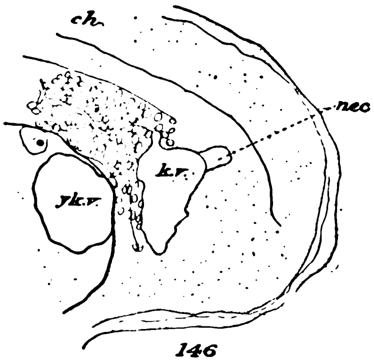

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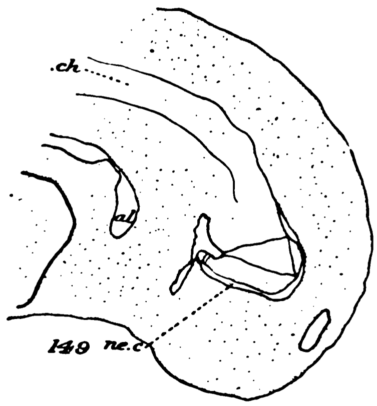

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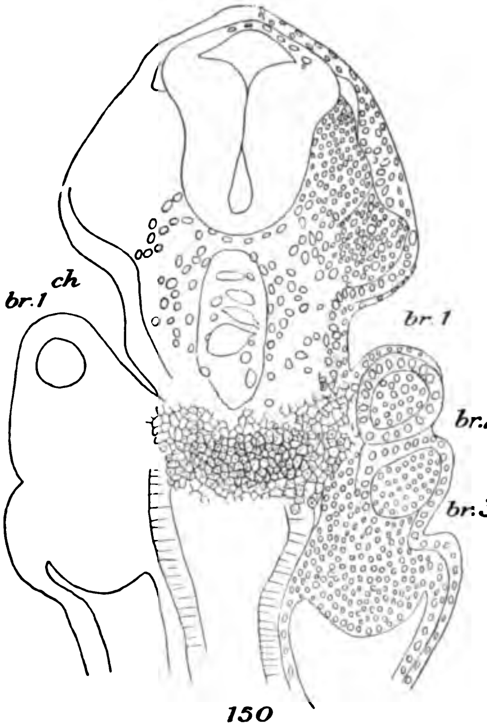

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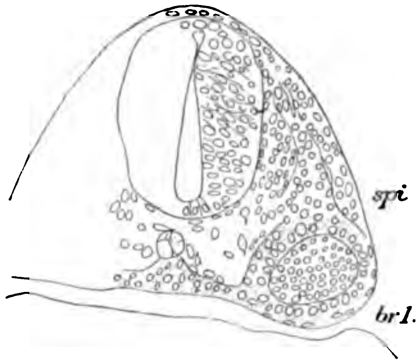

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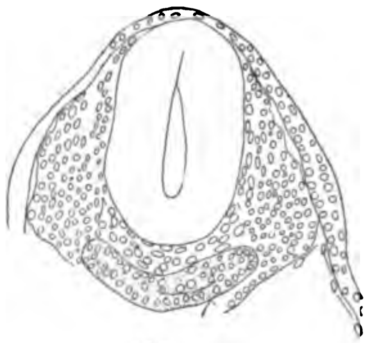

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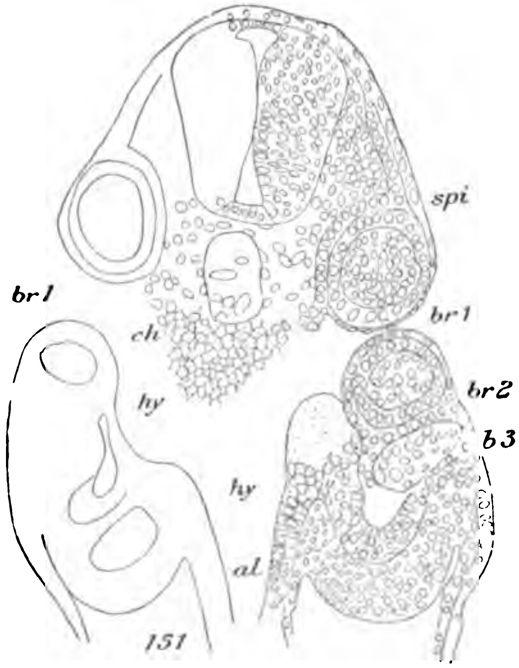

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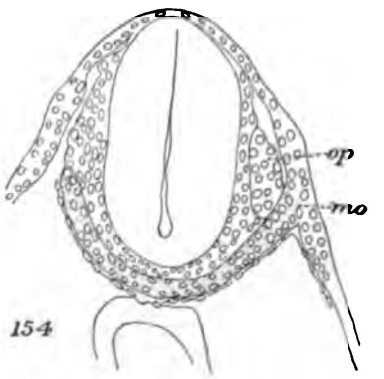

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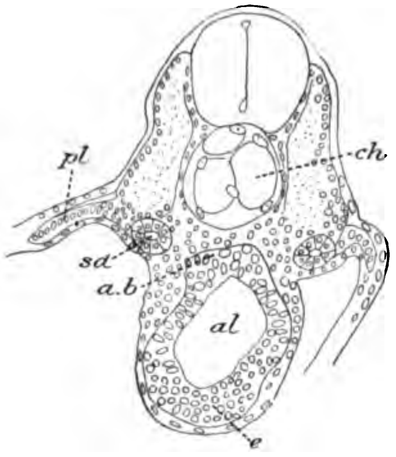

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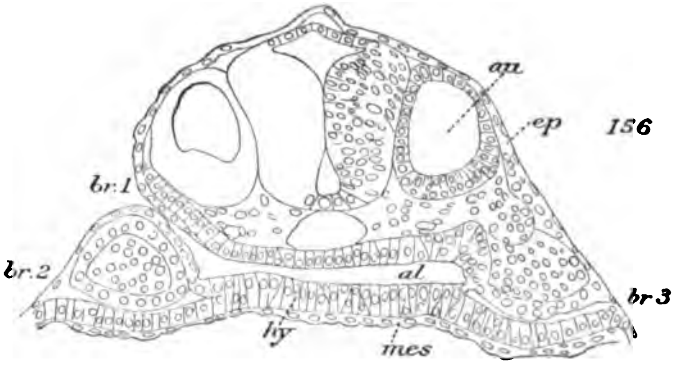

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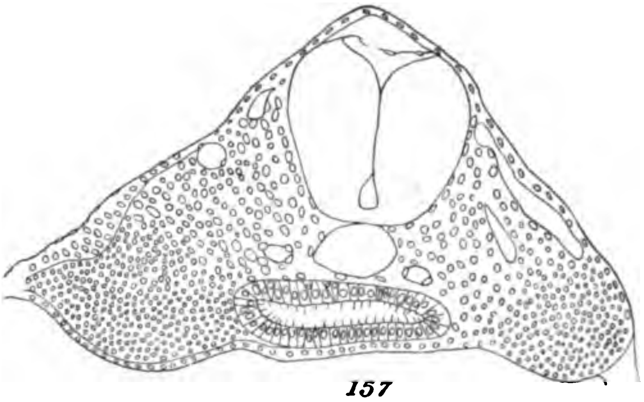

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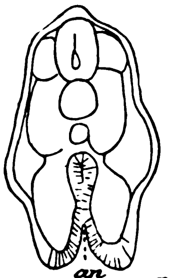

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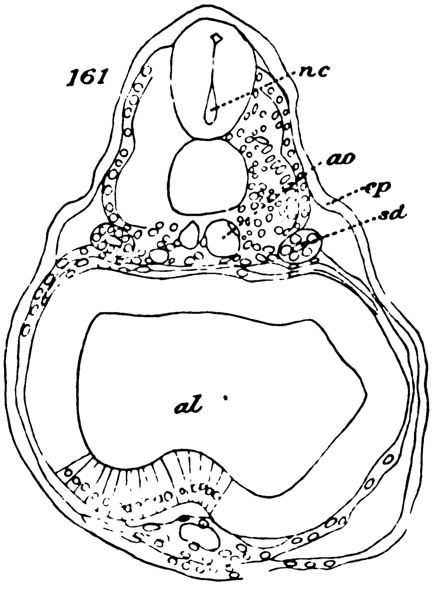

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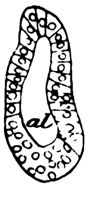

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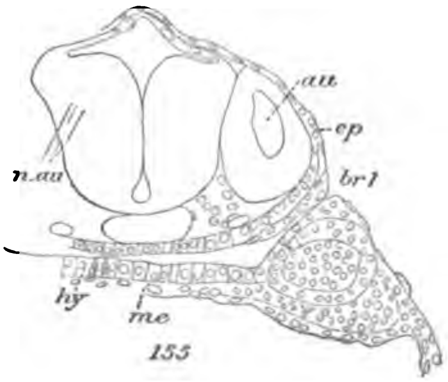

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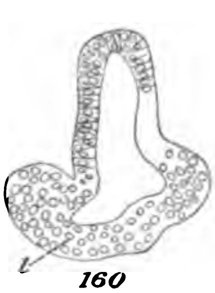

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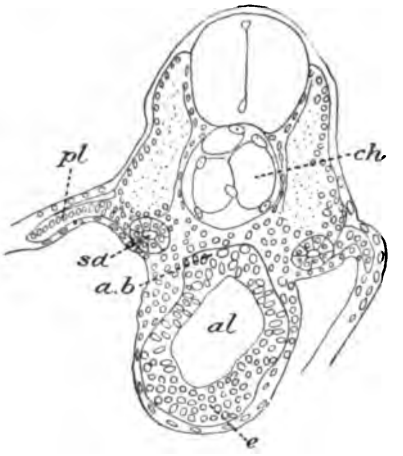

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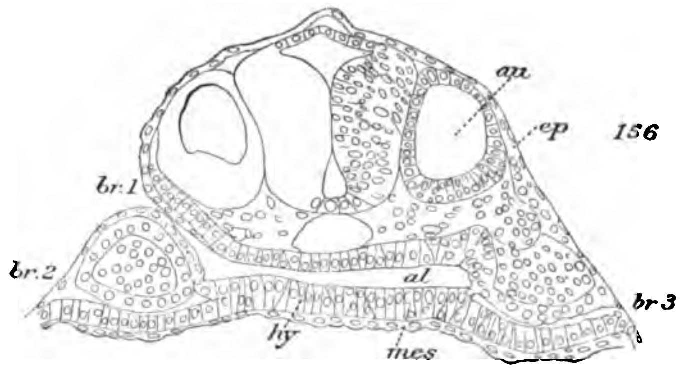

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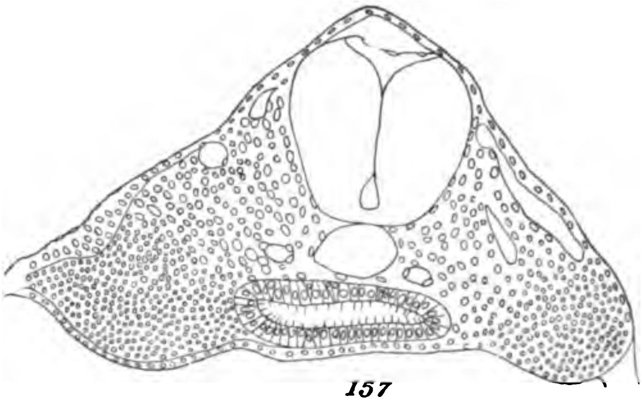

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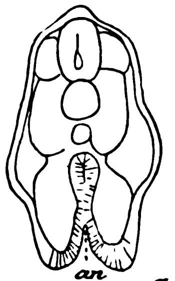

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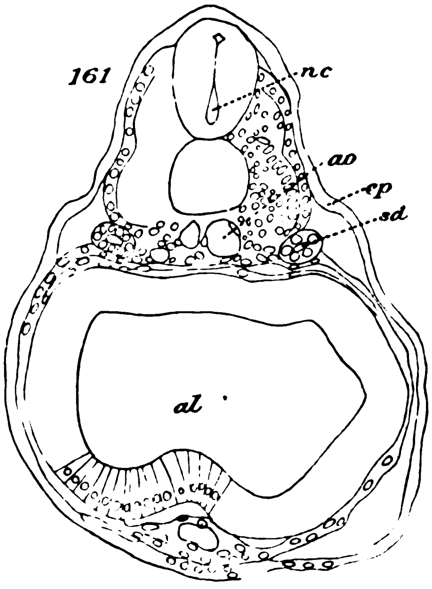

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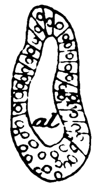

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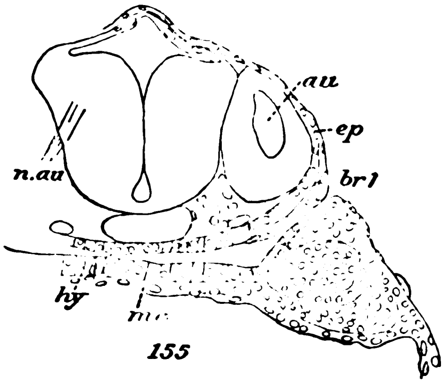

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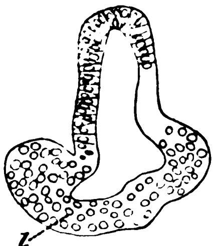

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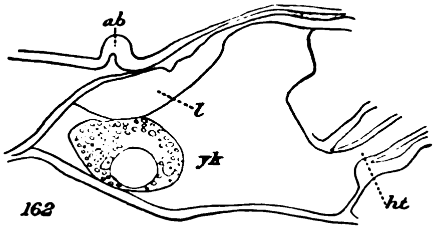

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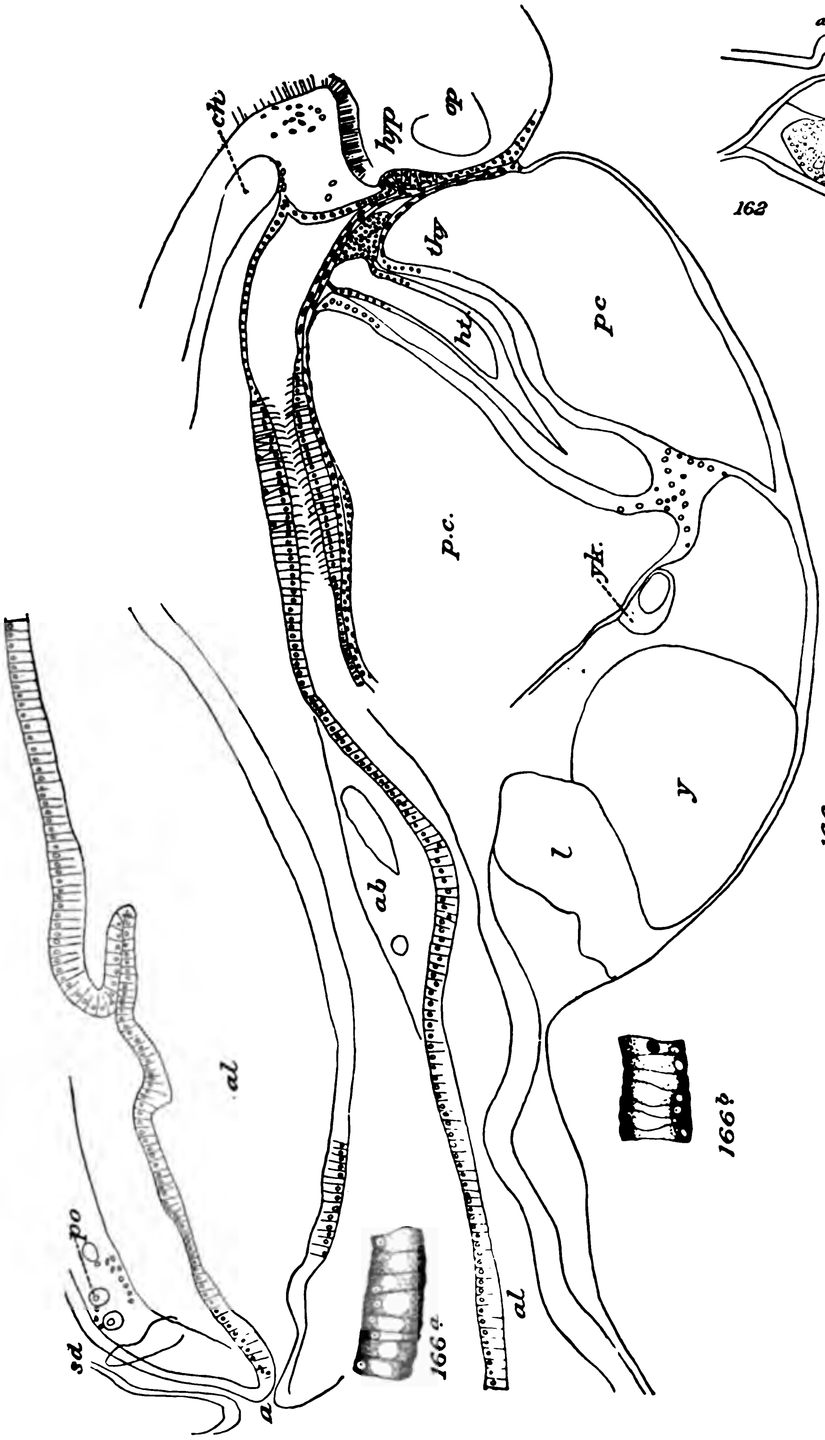

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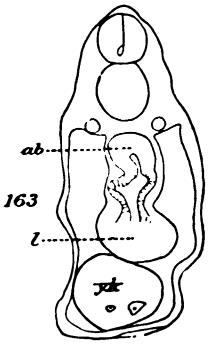

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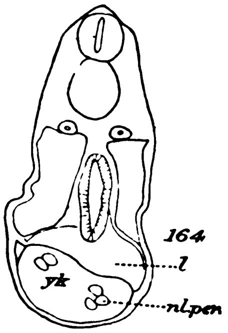

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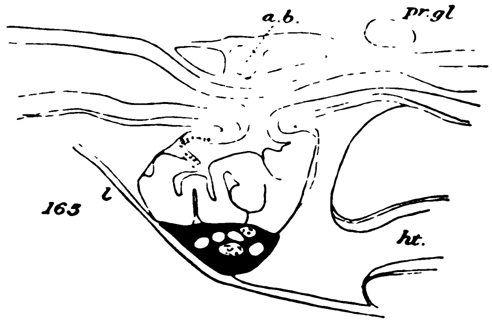

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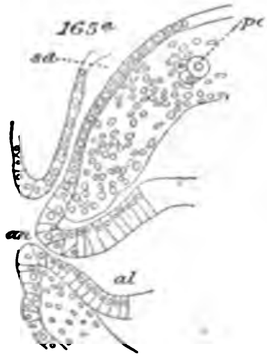

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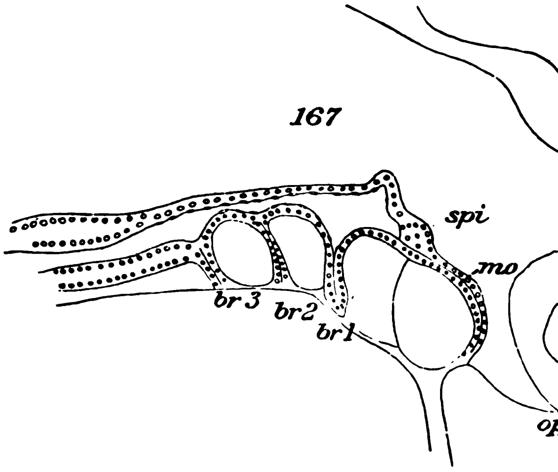

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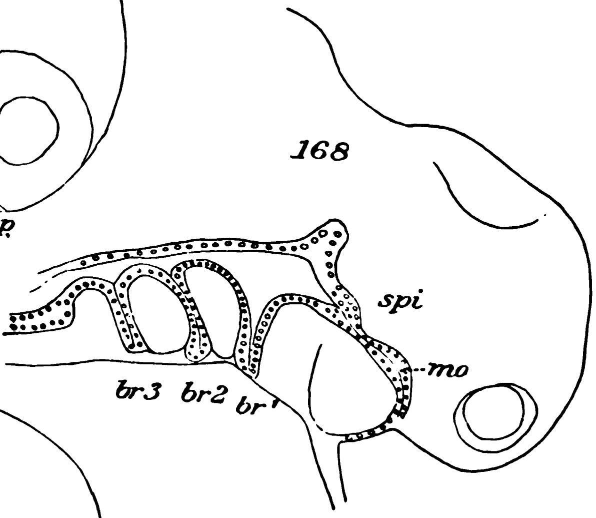

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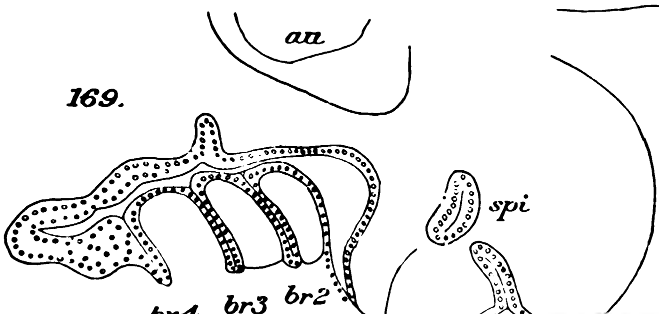

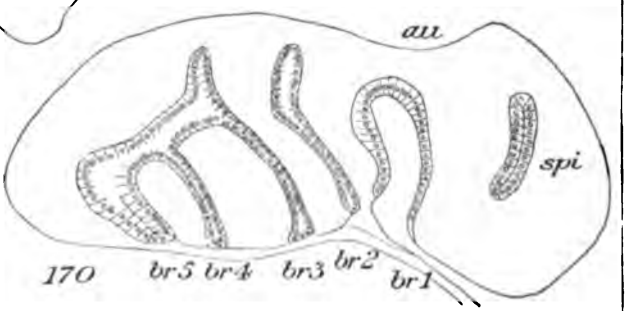

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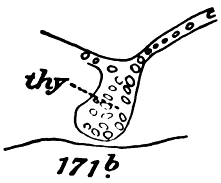

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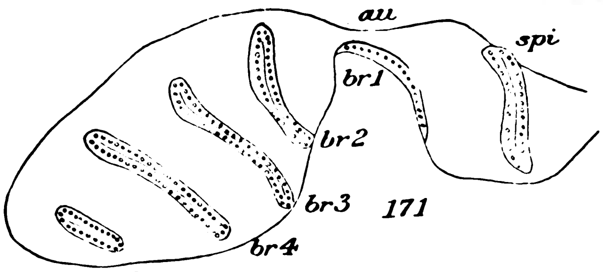

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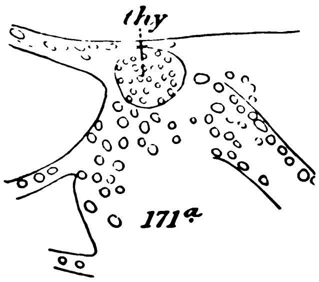

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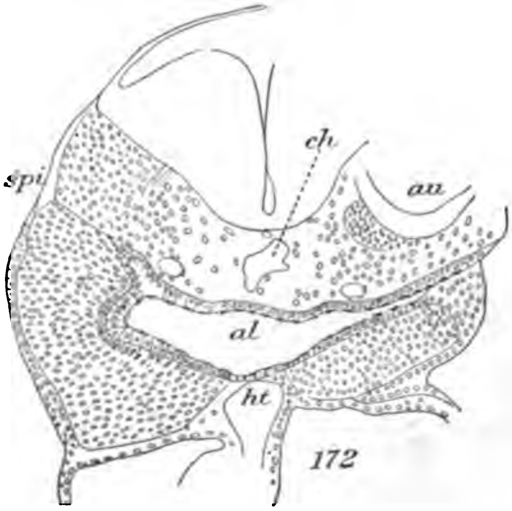

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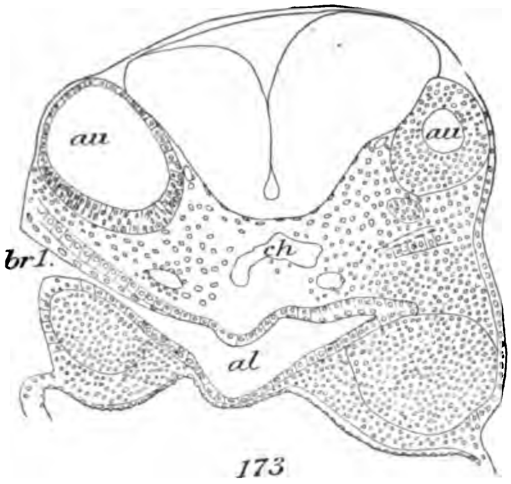

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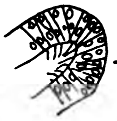

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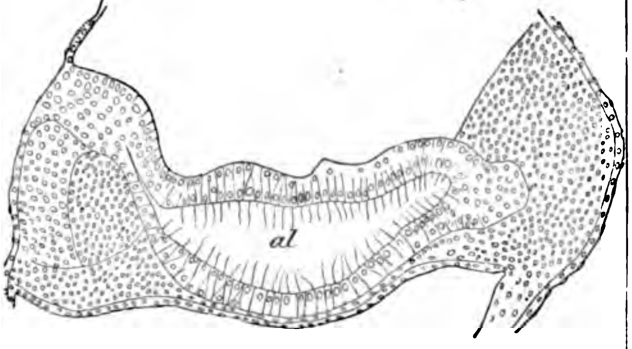

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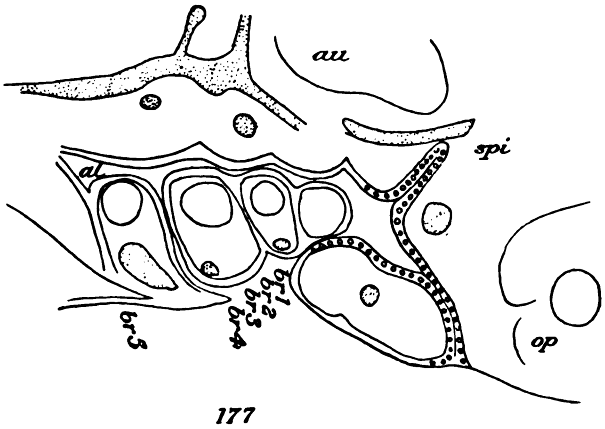

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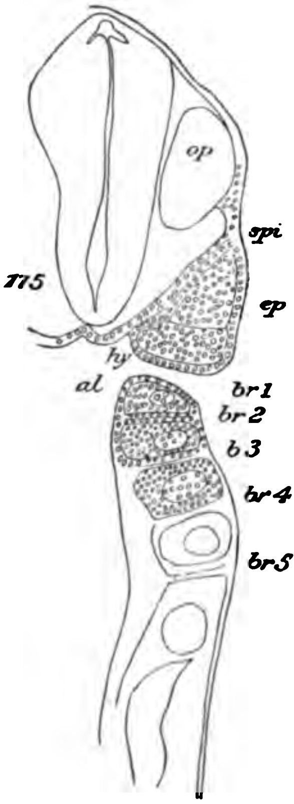

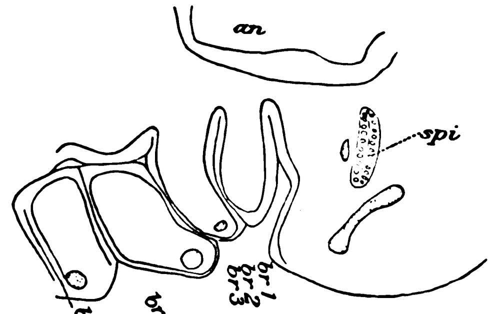

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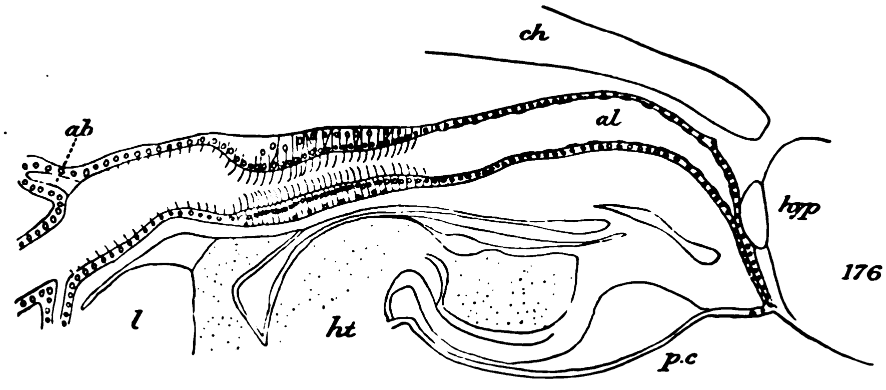

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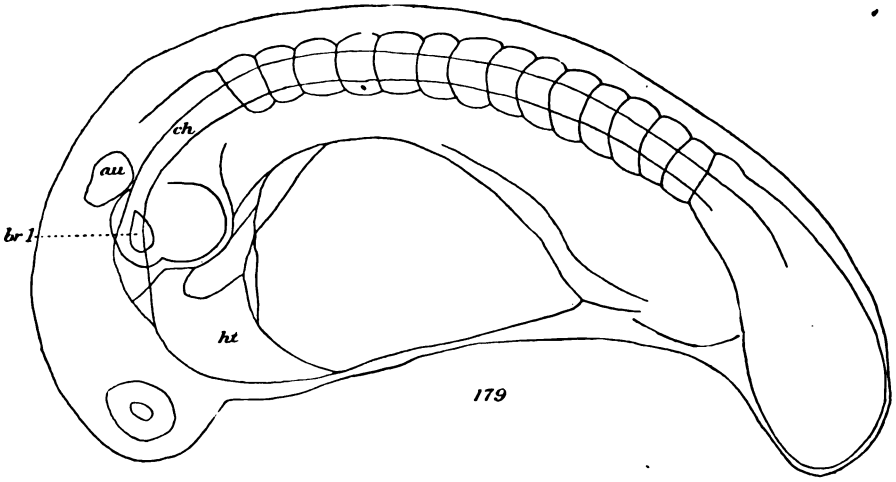

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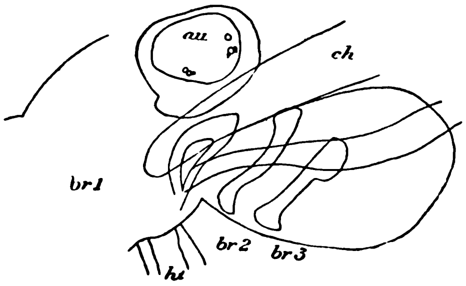

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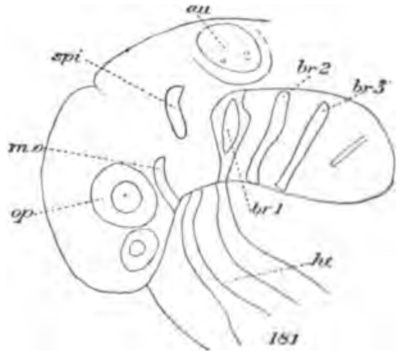

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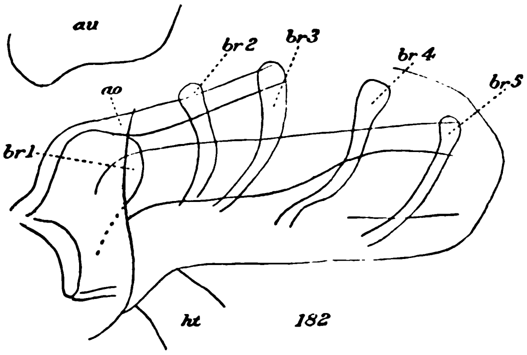

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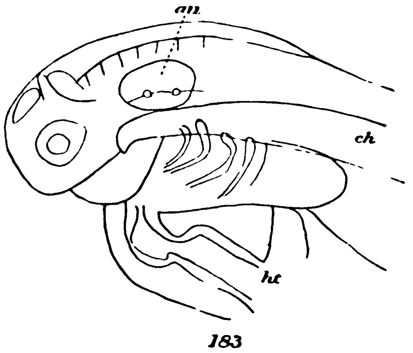

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